DEPARTMENT OF COMPUTER SCIENCE

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SHADOWS OF CAVERNOUS SHADES

CHARTING THE CHIAROSCURO OF REALISTIC COMPUTING

by

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Carissimis uxori parentibusque

Abstract

During the early 1990s, a novel style of programming often referred to as component-oriented programming quickly grew popular as the state-of-the-art in graphical user interface and client/server development on Windows-based personal computers, largely in competition with object-oriented programming, a partly similar, partly different programming paradigm, with which component-orientation is often compared, combined, and confused. Also during the 1990s, the world-wide web spread its arachnoid gossamer over the globe with deep-ranging ramifications for software component technology. Certainly, software componentry is not only a programming paradigm, but is closely wedded to complex component and distributed object infrastructures, such as Microsoft's COM/COM+/ActiveX and .NET, OMG's CORBA, and Sun's Java2 Enterprise Edition, which all provide support for a very wide range of functionality. One particularly intriguing, but widely overlooked development on this arena is the vision of "cooperative business objects" gestated by Oliver Sims and implemented by him and his colleagues in the Newi system. In the Newi vision, very high-level, loosely coupled, and independently executable objects modelling real-world concepts and co-operating through semantic messaging replace today's "programmes" and "applications", transforming the computer into a small world of "business objects". In the present study, the component and business object ideas and technologies will be explored from a number of different angles: The history of these ideas in software development will be traced, the usage of the terms "component" and "business object" analysed and contrasted to various similar concepts, and the technical principles, architectures, and infrastructures, on which they rest, surveyed and probed.

This done, the concept of "agendas of computing" will be introduced and a number of such agendas identified. On the basis of the aforementioned enquiry, a somewhat novel agenda of "realistic computing" will be proposed and outlined, being essentially an attempt to integrate several independent developments and trends in computing, which all point towards a common understanding of the computer as a "small world", including object-orientation in programming and user interface design, business objects, and 3-D "virtual reality" user interfaces. Notably, the business objects taken advantage of here should also be "components" unencumbered by the "fragile class problem", which has been identified as the Achilles heel of object-oriented programming by many advocates of component-orientation. In a rather detailed study of this problem, I suggest that some restrictions should be put on the object-oriented inheritance mechanism in order to eliminate class fragility. Thus will be born a new programming paradigm, "encapsulated programming", which unifies components and objects into "capsules", thereby also providing the basis for realistic computing. In addition, I briefly consider how today's component infrastructures can be used as a foundation for implementations of the agenda of realistic computing. Finally, I argue that by the amalgamation of a 3-D virtual reality user interface with Newi-style business objects – modified into "capsules" – a decisive step towards a more lifelike, "realistic" computer environment can be taken.

But there's a rub: Shall we really take this step and try to create such a phantasmal 3-D shadow world? What would the success of something like this imply for man and society? Why do we at all contemplate such a preposterous and strange idea? Such questions lead to others such as: What is computing really about? And what are the roots of all this restless technoscientific activity, the Faustian spirit of the West with its "modern project"? In a final section, I try to address such unduly neglected or even shunned questions through a comprehensive enquiry into many branches of knowledge, faith, and speculation, including metaphysics, the history of ideas, the history, sociology, and theory of science and technology, macro- and metahistory, theology, eschatology, ethics, and others as well. Having contemplated a plethora of apparently relevant topics, I attempt to apply the insights garnered to some of the most fundamental and debated problems of computer science. As a result of my studies, I finally come down strongly in favour of our good old ordinary reality and abjure the whole project of realistic computing as an unwholesome techgnostic fantasy.

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As the present piece of writing certainly did not come down to me from above through a thunderbolt or a windfall, but is the outcome of many years' laborious studies, enquiries, and ruminations, quite a few people have in one way or other contributed to or influenced it. Although most of them have done so only indirectly by their own writings, some have made a more direct impact or given me a helping hand in person and, consequently, deserve to be duly honoured.

First of all, I should like to thank my advisor, Dr. Eric Astor, to whom I owe so many cordial words of encouragement, judicious pieces of advice, and valuable suggestions. Without his good-natured supportiveness and broad-minded, philosophical bonhomie this work would and could most probably not have been written in the first place. The old-fashioned, unobtrusive, gently advisory way of monitoring thesis work that is his unfortunately seems to have become something of a *rara avis* in today's increasingly collectivist and conformist Academe. Let us hope that the good old spirit of the love of and free enquiry for the truth will one day come back again!

Furthermore, I wish to express my gratitude to a number of other persons, to whom I for various reasons also am obliged. Dr. Douglas McIlroy, Dr. Brad Cox, and Dr. Jean Ichbiah all kindly responded to my inquiries about their own rôles in the development of the software component idea. Dr. Wojtek Kozaczynski read and endorsed my account of *SSA's* submission to *OMG's* business objects effort. Anders Ive helped me to understand some of the more obscure aspects of the *Java* virtual machine and also to find a precious piece of *Java* esoterica. Christian Söderberg and I had many interesting and inspiring chats on the latest developments and trends in software technology. Prof. Andrzej Lingas and Dr. Christos Levcopoulos charitably came to my help at a critical moment in my work. Dr. Jan Bohman, the actual or acting head of the Department of Computer Science at the Lund Institute of Technology during all my years here, always was fair and square and ready to lend a hand in matters that concerned practicalities and my educational duties. Anne-Marie Westerberg scrupulously and expertly kept the accounts for my project. In my work, I frequently had recourse to the knowledge, skill, and helpfulness of the librarians at the Lund University Library as well as of Ola Hedbäck, the librarian of our department. Albeit not a computer scientist, Prof. Staffan Fogelmark many years ago taught me some very valuable things about scholarship, such as the importance of addressing interesting problems and attending to *prima facie* trifling details. My parents, Dr. Lennart and Ulla Persson, have inspired, encouraged, and supported my work in more ways than they perhaps realise. For a number of years, *Crafoordska stiftelsen* and *Helge Ax:son Johnsons stiftelse* generously sponsored my work, making it possible for me to acquire the computer equipment and other paraphernalia I needed for my project.

Last, but certainly not least, I want to thank my wife, Ingela Persson, who in a most unfailingly and unfashionably loyal, devoted, and pious manner has stood by, supported, and encouraged her husband throughout his thesis work, putting up with his negligence and eccentricities, the tedium of his endless soliloquies and dialogues on arcane topics, the invasion of her home by countless amorphous book and paper piles, and the penury that necessarily ensued upon the purchase of the tomes in these piles. At that, she has painstakingly proof-read and linguistically scrutinised every single page of the present, all too lengthy dissertation, although the solecisms that remain in the printed text will be due not to any slip of her eagle eyes, but to her husband's imprudent habit of incessant revision of his own writing, also after proof-reading.

1 PROLEGOMENA

1.1 INTRODUCTION

> *ἁρμονίη ἀφανὴς φανερῆς κρείσσων.*
>
> *Heraclitus*[1]

Amongst the metaphorical threads, from which so much of the fabric of our culture is woven, the image of the voyage will stand out as one of the more familiar and well-worn filaments, so to start a piece of writing by an allusion to the toils of committing it to paper as a voyage should establish with the reader a reasonably pellucid – albeit perhaps unreasonably hackneyed – picture of the author as a traveller in quest for some kind of Ithaca, be this but an illusory mirage or the real conjunction of the point of departure and the point of return, the harbour, at which the *’Ιλιοπόρος*, the setting out for Ilias, finally will be matched by the *νόστος*, the coming back home to Ithaca. Below, I will attempt to sketch briefly which the major stations of my own itinerary have been, hoping that I will thus be able to provide the reader with some intimations of why this piece of work has taken on the shape it has and which my incentives have been for so shaping it.

When I embarked upon my thesis work in 1996, I had spent about seven years working in a range of different software development efforts as a ‘programmer’ and ‘software consultant’ – indeed strange names for the strange occupation of a snake-charmer and spirit-raiser in the novel cult of the all-glorious, panacean wonder-machine, with which our times have become so extraordinarily besotted![2] The starting-point and backdrop of my research are to be found in various issues I encountered and observations I made during this period of practical work in software development, although the logic immanent in my researches later caused me to stray further and further afield in other directions. Certainly, these issues and observations have lead me to entertain views and perspectives that may, at least to some academic computer scientists, who do not share in such extramural experiences, seem unfamiliar, outlandish, or even suspicious and in some respects may appear to trespass against an unwritten, but nonetheless much cherished code of what academic computer scientists are supposed to busy themselves with. To most practitioners of the trade of computer programming, these issues and observations will, however, refer to problems that are both familiar and fundamental – in contrast to some of the issues, in which academic computer scientists delight, and certainly also to some of the issues, into which my own investigations in due time were to lead me!

One starting-point of this kind is the perplexing fact, well known to all who have been in the software development business for a while, that, despite the huge amounts of money and work invested in software construction, a very substantial portion of all software projects fails to produce the intended results, or produces them too late and only incompletely, and often does not manage to produce anything that is used at all.[3] This disturbing predicament, often referred to as “the software crisis”, is of course prone to become exacerbated by the grand technology shifts, which so rapidly tend to ensue on each other in the computer business, and can, despite the many proposals as to how to counter it and the partial relief regularly following upon the technology shifts through the arrival of new tools and methods for managing the novelties, hardly be said to have been adequately addressed and dealt with during the short history of software development, at least not in a general, technology-independent manner. Nonetheless, during my years in industry, I was fortunate enough to witness a promising and potentially, as it seemed to me, efficacious antidote to this malady starting being administered, viz. a mixture of “software components” and “rapid application development” *(RAD)* environments, the usefulness of which I first observed in the impressive results of other programmers and later was able to test out and confirm also for myself. At this point of time, this new software development paradigm was more or less synonymous with *Microsoft’s* programming environment *Visual Basic,* which, however, as I soon learnt upon my return to Academe, was a name most academic computer scientists shuddered and re-

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[1] Fragment B 54. “Invisible harmony is better than visible.”

[2] Cf. [Spen97] p. 1183 et seqq.

[3] Although somewhat dated, [Stra90] still synthesises many fascinating findings and pieces of information about the doubtful “business value of computers”.

coiled at – by knee-jerk reaction for sure, as only few of them had ever deigned to cast a glance at this marvellous produce, resting assured that "Microsoft" and "BASIC" were but other designations for "badness".

In my salad days in the late 80s, I had come under the spell of the three then rising stars of graphical user interfaces, *UNIX* workstations, and object-oriented programming. Of these, I saw the first, graphical user interfaces, succeed in the grand manner and the second, *UNIX* workstations, flounder almost unnoticed, being eclipsed by *GUI*-based 'personal computers', whereas the third, object-oriented programming, first seemed to sprout promisingly, but then, apparently failing to bring the expected fruits, seemed to start to wilt, struggling for life room against the harsh competition of the new generation of 'component-based' 'rapid application development' tools I just referred to. Like most programmers, I was much concerned with my tools and also took some part in the fray that at the time tended to break out ever and anon between the advocates of the *RAD* tools (usually *Visual Basic)* and the supporters of object orientation (usually *C++).* Although myself originally a stalwart supporter of the latter, object-oriented dispensation, both my own encounters with the two styles of development and a certain personal proclivity for the disaffirmation of 'politically correct', but essentially unsubstantiated notions – held by myself as well as others – made me increasingly Pyrrhonic about the object paradigm, at least in its then current shape, and increasingly curious about what kind of philosopher's stone that much-hailed componentry by virtue of which *Visual Basic* brought about its marvels really was.

The fetters of professional travail seldom offer much leeway for in-depth excursions outside the realms of immediate utility, and the perplexing imperspicuity of the *COM/OLE, CORBA,* and *OpenDoc* technologies, which were the protagonists in the 'component and distributed objects wars' that raged at the time, could not be dissipated by the rather perfunctory lucubrations I could afford to devote to the topic, so barring some intriguing *Lesefrüchte* garnered in the popular computer press my curiosity remained unsatisfied.[4] Anyhow, I gradually, albeit unwillingly and teeteringly at first, began to accept the view that component-based *RAD* – rather than object-oriented programming – provided the state of the art of computer programming and *GUI*-based personal computers (and in particular those running future versions of *Windows NT)* – rather than *UNIX* workstations – that of computing machinery.[5]

Upon my return from industry to academe as a graduate student, I finally got an opportunity to gain a better understanding of this "state-of-the-art", which I, besides, deemed to be the proper point of departure for my future researches. A roster of the problems I grappled with then may be seen as a key to my further work:

1. *Why do software development projects so often fail to deliver the expected goods? Which are the 'hard technical problems' underlying this failure (i.e. the much debated 'software crisis') as distinct from the 'soft problems' addressed by software engineering, project management methodologies, and suchlike?*

2. *Why did not object-oriented software development live up to the expectations nurtured by many (including myself) in the 80s and early 90s about its ability to dispel complexity, bring about large-scale reuse, and put an end to, or at least considerably abate, the software crisis? And in particular, why did not object-oriented programming turn out to be very successful in GUI-based client/server development?*

3. *Why did component-based "rapid application development", usually taking advantage of purportedly less powerful and less well-designed languages, such as BASIC – the all but proverbial bête noire of programming lore – seem to fare so much better, at least in the aforementioned domain? If component-based RAD is indeed superior, are there, on the other hand, any significant problems and limitations to this approach?*

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[4] Eye-openers to me (and many others) were *Microsoft's* spectacular introduction of its *OLE (Object Linking and Embedding)* technology in 1993 and the May 1994 *BYTE* special on "componentware", [Udel94a].

[5] These "state-of-the-art" technologies were of course mainly useful in a certain, although very large and important domain, which, somewhat vaguely, can be referred to as *client/server systems,* whereas in other realms, such as *embedded systems* and various other varieties of 'technical programming', they may for various reasons have been less appropriate or impossible to use.

4. *Can object-orientation and component-orientation be reconciled? If so, what will the advantages, disadvantages, and other implications of such reconciliation be?*

5. *How can the current "state of the art" of component-based* RAD *development be furthered?*

At first sight, one may baulk at the scope, complexity, and difficulty of these issues – particularly when looked upon as a whole –, and one may well surmise that some of them will need very large-scale and long-time efforts to be addressed adequately or may even be perennial companions of software development, at least if some more general 'silver bullet' placeholders (like 'technology A' and 'technology B') are substituted for the currently popular concepts 'object-orientation', 'components', and *'RAD'!* Indeed, it would be both fatuous and presumptuous to believe that they could easily be done away with through some facile recipe or nostrum, and whatever answers one may come up with will certainly be tentative, incomplete, and in need of further revision. Nevertheless, these 'big questions' were, I thought, highly relevant and worthy of study, in particular as some of them had received oddly little consideration in academic research, largely, it seemed, because of the "unwritten code" of computing academe I initially alluded to.

Certainly, one may challenge the above – admittedly somewhat vague and sweeping – formulation of problems in various ways, for example by questioning whether there really is a 'software crisis', i.e. if software development projects fail or are delayed more frequently than other kinds of engineering efforts, whether this 'crisis', granted it exists, has any technical roots at all, or whether object-oriented software development really has been shown to be less successful than component-based *RAD* in *GUI*-based client/server development. Although it is *not* the purpose of the current study to establish the soundness of my problem formulation, I will later attempt to undergird it by references to various scraps of information, although these will, unfortunately, be more scant than I should wish and partly rather anecdotal in nature, and, thus, possibly inconclusive to the incredulous. This deplorable situation is, however, characteristic also of the – typically seldom explicitly stated or debated – problem formulations on which rest most other branches of computer science. These branches, typically being imbued by either a strong mathematico-deductive or an equally strong hacker mentality, or – more often – both, have generally been loath to subject its axioms and presuppositions as well as its precepts and commendations to experimental or kindred evaluation beyond the simplistic one of programme execution.[6] Indeed, all science – or rather all human interpretation, theory, and understanding, scientific or not – rests upon metaphysical presuppositions that have not and very often cannot be verified and may even be at odds with well-documented observations.[7] But although I, for one, am assured of the reasonability of my own problem formulation on the basis of my former experiences and observations as a software developer, one hardly needs to be so in order to be able to appreciate the ideas and results that I will present below. It should also be borne in mind that I am here primarily concerned with a certain domain, viz. client/server-based *GUI* systems, which may in important respects differ from other domains of software construction.

At any rate, with the above problems in mind I embarked upon a reasonably ambitious study and reading programme, perusing or skimming substantial portions of the – rapidly growing – literature on software components, distributed objects, and various related topics. Somewhat put off by the highly specialised approach of much of the on-going research in computer science and its lack of bearing on the problems I had seen as a programming practitioner, I wanted to take a more general, top-down tack[8] in order to arrive at a proper *understanding* not only of these problems, but also of computing at large. In a number of studies, I surveyed

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[6] One notable exception, bearing out the utility of experimental validation well, is provided by the user interface research community, for which usability testing will largely be a matter of routine, another by the various experimental strains of research in software engineering. [WRHO+99] is a recent book on the experimental approach to software engineering.

[7] [Burt99]. Cf. also [Coll72], [MM88], [Clou91], [Harm91], [HC94], [Broa69] p. 1 et seqq., [Love64] p. 7 et seqq., the discussion of Whitehead's "climates of opinion" – a term he actually borrowed from Joseph Glanville – in [Beck32] p. 1 et seqq., and the significance imputed to *Vorverstehen* in hermeneutic theory. Already in the 19th century, Lotze pointed out the importance of metaphysical presuppositions (see [Pest97] and [Aspe77] vol. II p. 284 et seqq.). According to [Hatf90], the metaphysical presuppositionalism of Burtt and some other historians needs qualification.

[8] Cf. [Wegn99].

topics such as possible infrastructures for software components[9], the history of the software component idea[10], the relationship between components and software engineering[11], client/server *Internet* computing[12], "business objects"[13], and virtual reality and 3-D user interfaces.[14] Large portions of these topical studies, which should be conducive to a better understanding of the concepts *software component* and, in particular, *business object,* their history, importance, problems, etc., have been integrated into the present thesis.

At the early stage of my work, one major imprint on my outlook was made by Brad Cox' intriguing analysis of the economical background of the software crisis and the significance of various economical considerations for the success of software componentry, another by Oliver Sims' plea for directly user-manipulable, large-grained, independently executable "cooperative business objects", which act as representatives for real-world concepts.[15] What with the impact of Sims' writings and my prior experiences in developing medical record systems, I soon came to identify "business objects" – the "ultimate components" in the wording of the proficient author trio Orfali, Harkey, and Edwards[16] – as a most promising research topic, which, to me at least, appeared to be capable of promoting the current "state of the art", as defined above, considerably.

As a kind of framework or scaffold for my research on *business objects,* I established the *Panopeus project,* which owes its name to the little town Panopeus in Phocis in Greece, where, according to the myth, Prometheus formed the first human beings from clay and Pallas Athena thereupon brought these clay figures to life by breathing her spirit into them.[17] Although the connection between such acts of titanic-divine creativity and the notion of the computer as a humanly engineered "electronic brain" may strike one as rather obvious, such a grandiose parallel was not what I primarily had in mind when I named my project, but rather I thought of "creating objects" and "bringing them to life" from the object-oriented and component-oriented programmer's more pedestrian point of view. Anyhow, the *Panopeus* project enabled me to get the pecuniary support necessary for the practical side of my research from *Crafoordska stiftelsen* and *Helge Ax:son Johnsons stiftelse,* hereby gratefully recognised.

Under the auspices of the *Panopeus* project, I intended to investigate and develop Oliver Sims' *business object* vision in various ways. For one thing, I thought *business objects* needed to be based on a less exotic infrastructure than the *Newi* software that Sims and his confrères had put together in the early 90s and to be made *au courant* with the current state of the art in *GUI*, distributed objects, and software component technology. The latter requirement pointed towards the need for the reconciliation and unification of the *component* and *object* concepts, a task to which had also been paid some attention in recent research. To this same task I devoted considerable effort, which eventually resulted in my suggesting the novel programming style of *encapsulated programming,* underpinned by a basic building block of programming, which I called a *capsule.*[18] By placing a few restrictions on the inheritance mechanism of object-orientation, *encapsulated programming* attempts to eschew the "fragility" problems held to be fatal for software componentry.

During collateral studies of user interface and *virtual reality* technology, it suddenly occurred to me that to interbreed 3-D *virtual reality*-style interfaces and *Newi*-style *business objects,* which both body forth a strong thrust towards a kind of 'realism' based on a conception of the computer as an artificial 'mirror world', might be a most serendipitous thing to do, which, perhaps, would be capable of lubricating the adoption of 3-D user interfaces considerably. Upon further reflection, I came to believe that it was possible to discern in the development of computing a fair number of long-ranging tendencies that all beckoned towards a similar 'realistic'

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[9] [Pers97]

[10] [Pers98b]

[11] [Pers98a]

[12] [Pers99a]

[13] [Pers00b]

[14] [Pers00a]

[15] See [Cox96] and [Sims94].

[16] [OHE96b] p. 38.

[17] See [Rose59] p. 54 and [Prel1872] p. 80. On the Prometheus myth in general, see [Ragg58], [Duch74], [Wutr95], [Krei94], and [Keré97].

[18] [Pers99d] presents the basic ideas of *encapsulated programming,* although I did not use this term at the time.

end-point and, hence, I ventured to formulate a foundation and overarching framework for these tendencies in the form of the 'agenda' of *realistic computing,* which through the combination of *business objects* and *virtual reality* interface technology, attempts to provide a somewhat new-fangled understanding of the computer as a kind of "world creator", to be distinguished from the settled interpretations of it as a "calculator", an "electronic brain", a general-purpose "tool", etc.[19] The investigation and development of this agenda now became the unitive principle and foremost goal of my thesis project, causing me to expand my studies into the realm of virtual reality, cyberspace, and a plethora of related topics.

Then again the encounter with the philosophically tinged portion of the literature on *virtual reality* – as well as the ethical dilemmas involved in the participation, however humbly and peripherally, in the development of the kind of Faustian technology that *virtual reality* in actuality is, being flush with doubtful or dreadful implications to humanity – soon started me on a somewhat different track. Not only did it now seem necessary to me to arrive at a better understanding of the roots of computing at large and the technologies I worked on in particular, but as I delved further into these matters I came to recognise the necessity to come to terms with *science* in general, the magnificent claims about it as *the* way to truth, the philosophical and ideological attempts to underpin or undermine these claims from different quarters, and the complex relationships between science and other systems of belief and thought, be they theological, philosophical, ideological, or of some other kind. As I became increasingly aware that the invention of the computer was in itself part of metaphysical projects, the roots of which can be traced back very far in history and are complexly, subtly, and enigmatically linked to the realms of religion, theology, philosophy, myth, the occult, etc., I realised that I would have to examine these roots at some length as well. Consequently, I started to read extensively on a great number of topics, which seemed crucial not only in order to understand computing and computer science properly and to put them into a wider perspective, but also to tackle the question of the meaning, value, and importance of scientific and technological pursuits in general. Although I did not have to start this effort altogether from scratch, as I had since my late teens always taken a certain interest in topics such as theology, religion, philosophy, and parapsychology, and also had some academic grounding in the classics and the history of ideas, this pursuit, predictably, turned out to be a great deal more complex, intriguing, and time-consuming than I had initially been able to foresee. Gradually, it also came to appear to me as the by far most significant and interesting part of my study.

Thus, I was led to re-consider firstly the roots, legitimacy, and meaning of science and technology at large as well as the various attitudes, thought structures, and ideologies, by which they are surrounded and buttressed, and, secondly, the entire "modern project" that sired this overbearing, seemingly invincible leviathan in the first place. From the issues of the roots, legitimacy, and meaning of modernity, post--modernity, and pre-modernity, I was ineluctably led on to the plethora of evergreen issues, around which our present positional *Lebens-* and *Weltanschauungen* tend to crystallise.[20] Albeit having a great fascination with most people, these issues often seem to instil in men of science such a profound uneasiness and aversion that they either shy away from them altogether or try to skirt or defuse them by some cheap, angry, or dogmatic verbal conjuration. In fact, I was soon clear that on many of these issues I had to beg to differ from the simplistic and unrealistic opinions prevalent amongst scientists, engineers, and humanist scholars alike. It will hardly be possible even to touch upon these topics, let alone to advocate views and conclusions about them that go but a little against the grain without causing a major bloodshed on sacred cows almost universally worshipped amongst men of science and scholarship. Rubbing salt in these bovine wounds, I have also throughout my work seen fit to adopt a more "scholarly" or "humanist" approach and writing style than is common in the sciences in general and in computer science in particular in order to, if possible, unsettle the widespread – although often only tacit – supposition that there is an unbridgeable gulf between the 'two cultures' of science and the humanities and that the proper pursuit of science necessarily implies the use of bald and soporific prose and the bluntest possible manner of presenting the 'facts' or 'results', shorn of all reflection on their historical, philosophical, theological, and other settings and bearings.

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[19] [Pers98c] and [Pers99c] contain the 'manifesto' for *realistic computing,* at two different stages of its evolution.

[20] These 'deep' questions will – just to name a few of the most important ones – include the possibility and proper basis of knowledge and the acquisition of truth, the status and interrelationship of mind and matter, the existence and nature of God, the soul, spirit, and spiritual beings, the permanence and destiny of the soul after death, the significance of religious, mystical, and paranormal experiences, the presence of a common 'core' of a certain kind in different religions and philosophies, the importance of the Christian faith most people in this country formally belong to, but few even care to pay lip-service to any longer, the origin of cosmos and life, the meaning of history, and the message and meaning of modernism and its adjunct nihilism and materialism,

The current work falls into five main parts, of which each deals with some of the topics discussed above, to wit, in turn:

- software components
- business objects
- the agenda of "realistic computing"
- the philosophy and ethics of computing
- "networked components" as implemented in *Microsoft's DNA* (in the form of an appendix)

The first two chapters as well as the appendix are intended to contribute a thoroughgoing and probing conceptual, historical, and technical analysis of the areas of software componentry and business objects, on which the agenda of "realistic computing" is based and intended to improve. The third part provides an outline of this very agenda and suggests solutions to different problems related to it. The fourth chapter primarily addresses the difficult question if something like "realistic computing" is really desirable or at all ethically defensible, but also offers an interpretation of the deeper significance of computing – what the computer *really* is and is all about – by relating computers and computing to a wider philosophical, theological, and historical context. This section will be the by far longest and, in my own contention, the most important contribution of the present work.

But before going into the real subject matter of this thesis, I should like to make a few remarks on the methods I have relied upon during my work. Albeit not very common in computer science currently[21], it is customary in many other areas of research to begin a doctoral thesis with a sizeable meditation on "methodological questions", apparently largely so as to assure one's colleagues that one is not a total ignoramus with reference to the current trends and fashions of academe and one's own discipline. Although I have little hope to be able to achieve something like that, I believe that I ought to say something about what the principles and basic standpoints that have guided me in my work are. Since expatiation on such topics may indeed invite scattershot garrulity, nebulous froth, and unbearable pontification, I have, in order to, as far as possible at least, avoid these fallacies, made every effort to keep this section as brief as possible, neither straying too far afield into the superlunary spheres of whirling and wuthering meta- and cross-perspectives, nor adjudicating as lightly and frivolously as human nature tends to predispose us to in such matters, in which humbleness, constraint, and the suspension of judgement will rather be appropriate virtues. For the benefit of the reader who takes some pleasure in such divertissements, I have, however, attempted to qualify and develop some of the viewpoints in the footnotes.

[21] In dissertations in informatics methodological discussions occur rather commonly. See, for example,. [Flen86] or [Ågre98a].

> *The most pervasive and effective forms of pseudo-science are those that form the penumbra of science itself. The leading example is positivism or scientism, the belief that the methodology of the natural sciences is capable of answering all questions and is therefore the only valid form of knowledge. What is intriguing about this suggestion is not the groundless nature of the assertion itself. Most astonishing is the extent to which it is persisted in even when it yields no fruitful results and when subsequent reflection reveals its inherent irrationality.*
>
> *David Walsh*[22]
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> *Contemporary university culture is hollow at its core. Not only does it lack a spiritual center, but it is also without any real alternative. Although many of the most prominent academics are preoccupied with politics, they are unable to produce a compelling basis for preferring one set of principles over another. On the contrary, while they tend to be dogmatic moralists, many also espouse theories that would undermine not only traditional moral norms, but their own as well. Others, probably most academics, do not even try to deal with first principles.*
>
> *George M. Marsden*[23]

Doubtless the current study differs considerably from most Ph.D. theses in computer science, no less in its style than in its general drift and approach to the topics dealt with. In computer science, as indeed in most branches of today's science and technology, the reliance on costly equipment and machinery tends to necessitate, or at least make exemplary, the conglutination of highly structured teams of closely co-operating researchers, each such team in addition owing allegiance to a larger community of like-minded groups that work on similar problems by similar methods with similar equipment. A view of thesis writing as a kind of strictly regulated apprenticeship is naturally favoured in this craftsmanly milieu, leaving only very limited leeway for personal interests, tastes, excursions, peculiarities, or whims on the part of the individual researcher. Such a corporate mind-set, the habit of multiple authorship of papers, and the strong sense of community affiliation, reinforced by the habit of incessant conferencing with its – often severely homogenising – peer-review approbation process[24], conspire to ascertain a strong per-community uniformity in the problems considered interesting, the presuppositions taken for granted, the methods relied upon, the viewpoints and attitudes commonly expressed, the – usually markedly unadorned and depersonalised – writing style of the publications, etc. Of course, there will be considerable variety between different scientific subcultures, of which each, for one thing, embodies its own distinct *Denkstil* or "style of thought", to use Ludwik Fleck's felicitous term.[25] These "epistemic cultures"[26] or "communities of belief"[27] and their inner workings have been illuminatively studied from a psychological or sociological point of view by the practitioners of the *sociology of scientific know-*

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[22] [Wals92] p. 142

[23] [Mars97a] p. 3

[24] On the rôle of "confirmatory bias" (the tendency of peer reviewers to support papers that confirm their own views and reject those that do not) in the peer review process, see [Maho77]. Cf. also [Maho76] p. 79 et seqq. and [CH90].

[25] [Flec99]. Notably, the idea of styles of thought is picked up in [Crom94], A. C. Crombie's 3-volume magnum opus *Styles of Scientific Thinking in the European Tradition,* where six distinctive styles of scientific argument are distinguished: 1) *postulation,* the deductive mode of reasoning typical of mathematics, predominant in ancient Greek science and still, of course, going strong, 2) *experimental argument,* of limited importance in antiquity, but swiftly growing in importance and sophistication from the 13th to 17th centuries, 3) *hypothetical modelling,* going back to the earliest times, although nowadays often taking advantage of complex mathematical algorithms (cf. J. David Bolter's suggestion in [Bolt84a] p. 15 et seqq. that each age tends to espouse an especially important model, a *defining technology,* that serves to explain all kinds of phenomena, e.g. the potter's wheel in antiquity, the mechanical clock from the 14th to the 17th century, the steam engine in the 19th century, and the electronic computer in our own time) 4) *taxonomy,* having its roots in ancient Greece (with Hippocrates, Plato, Aristotle, and others), but growing considerably in sophistication during the 17th and 18th centuries, 5) *probabilistic and statistic analysis,* which saw daylight in the 16th/17th centuries and has evolved rapidly ever since, and 6) *historical derivation* (or *the genetic method),* which, albeit in gestation since the early modern period, had its acme during the 18th and 19th centuries and is particularly popular in geology, biology, and cosmology. Fleck's *Denkstil* is, of course, a more sociologically oriented concept than Crombie's cross-disciplinary *styles of scientific argument,* as it is used to denote the ways of thought of a certain *group* of researchers. See also [Gayo96] for a short survey of the use of the concept of style in the history of science.

[26] [Knor99]. Cf. also the notion of "cognitive minority" in [Berg90a] p. 6 et seqq.

[27] [Brig89]

ledge (SSK) so as to clarify how sociopsychological and organisational factors affect and mould science, scientific knowledge, and scientific change. A seminal, classic, and forthright account of the not very prepossessing communal behaviour of scientists during the rhythms of long, dull periods of "normal science" – characterised by endless games of "puzzle solving" – and the short spells of revolutionary "paradigm crisis" that once in a blue moon interrupt the usual treadmill was provided by Thomas Kuhn in *The Structure of Scientific Revolutions*.[28]

That the highly communal ways of disciplining and tempering creative mettle and impetus relied upon in most scientific pursuits may be efficient for long-ranging efforts and complex tasks may seem to be well testified to by the impressive results of many research efforts organised along such lines.[29] For all its triumphs, this mentality and modus operandi, however, also runs the risk of fostering diverse vices, including notably 1) a fragmentation of knowledge – the flip-side of specialisation – that may abet blinkered lopsidedness, lack of perspective, ideological deformation[30], and, in the end, superficiality and "false consciousness", 2) a proclivity for dogmatism that, although, at least according to some, possibly beneficial or even necessary for the stability of the "research programme" pursued, may easily degenerate into truculent sectarianism, arid senility, and hectoring hostility to critical, novel, or different views and even to data that do not fit with the assumptions of the thought style espoused (i.e. *anomalies* in Kuhn's patois)[31], 3) the risk of driving off gifted scholars of a non-conforming, imaginative, or just unsociable turn of mind, and 4) all the well-known fads and foibles of human beings in crowds.[32]

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[28] [Kuhn70]. Interestingly, Kuhn was influenced by Fleck when he conceived his paradigm theory (see id. op. p. vi et seq.); *paradigm* in the sense "disciplinary matrix" (id. op. p. 182) is largely synonymous with Fleck's *Denkstil.* Kuhn's thesis is discussed from various viewpoints in, for example, [LM74] and [Hans92a]. [Goli98] provides an excellent survey of contemporary constructivist thought in the study of science and its history, of which Kuhn can be regarded as one of the fathers. There are many varieties of constructivism, notably 1) the *philosophical/epistemological* variant implicit in Kant's transcendental idealism (and indeed being traceable further back, at least to Nicholas of Cusa and William of Ockham), according to which our experience is synthesised through a priori forms *(Formen der Anschauung* and categories), and elaborated in various directions by numerous latter-day philosophers, 2) the *linguistic* one – broached by Hamann in his *Metakritik* (see [Hama21]), brought to fruition by Herder and von Humboldt, and revitalised by Whorf, Snell and the late Wittgenstein in the 20th century (see [Whor56] and [Snel80]) –, making our language and its grammar shape our experience decisively, 3) the *biological/neurological* one of, for instance, von Uexküll or Maturana and Varela, claiming that our experience or *Umwelt* is constructed by the subject or the brain through an act of "autopoiesis" (see [Hayl99] p. 131 et seqq.), 4) the *sociological* one handselled by Scheler as *Wissenssoziologie* in the 1920s (see [BL66] p. 4 et seqq.), in which the impact of social factors is focused on. Other variants exist as well, or can easily be imagined. Notably, there is a strong element of constructivism in Mahayana Buddhism, most strikingly in Asanga's *Vijnanavada* (see [Glas80] p. 207 et seqq.), as well as in Shankara's *Advaita Vedanta* and some other Indian philosophy. Western constructivism has largely grown from the relativistic hotbed of historicism and various comparative approaches. It is important to realise that there is a gliding scale between strong constructivism in its purest form, which denies that we can find out anything at all about the 'reality' beyond our own constructions, i.e. the elusive *Ding an sich,* and all kinds of weaker constructivist positions that are more optimistic as to the possibility of getting some purchase on reality. [Hack83], which advocates a moderate scientific realism, contains many good discussions of the points at issue as far as the natural sciences in general and physics in particular are concerned.

[29] [Jani94] p. xii et seq. discusses what he aptly calls the *giantism* of science and how it presupposes the subordination of the individual.

[30] Cf. [Voeg96] p. 95: "Generally speaking, the reservoirs of reality in our society are to be found in the sciences that deal with intact experiences and symbolizations or reality, even if the sciences themselves have been badly damaged by the influence of the ideological climate." Cf. also [Midg85] and [Midg94].

[31] According to Lakatos' theory of *research programmes* (proposed in [Laka65]), the hard core of a research programme has to be protected by all means against anomalies. But whereas *dogmatism* and *orthodoxy* may indeed be defended in theology as a safeguard and 'protective belt' of *divine revelation* against all kinds of corruption and distortion brought about by *human* insipience, it seems, *pace* Lakatos, indefensible to treat science and, for that part, philosophy, which both are supposed to be open quests for truth, as though their theories, albeit the achievements of fallible *human* beings, had also come down to us through some kind of infallible divine revelation. Although it will be true that a good theory should not be given up light-heartedly as soon as some minor difficulty crops up, it seems that Lakatos' ingenious argument, despite its descriptive merits, in the end boils down to little more than an inglorious defence and doubtful *Ehrenrettung* – and, worse still, an implicit legitimisation – of the obvious and highly embarrassing malfunctions of the scientific process brought to the light by Kuhn and the other sociologists of science. Instead of a defence for irrationality, a suggestion of proper medication against it would arguably have been much more useful and commendable. In [MD77] are reported the results of a comparative test of the problem-solving and reasoning skills of Ph.D. scientists and conservative Protestant ministers, showing no significant difference between the two groups in problem-solving efficiency, but an embarrassing "penchant for quick speculation and tenacious fidelity to a hypothesis" amongst the scientists. See [Milt96] for many striking and thought-provoking examples of the hidebound, self-interested, and insipid behaviour of the self-styled guardians of scientific right-thinking and some interesting remarks (p. 105 et seqq.) on the difficulties of scientists to handle what Leon Festinger in his famous study [Fest57] called "cognitive dissonance" in rational ways. Cf. also [Barb61]. See also Cremo and Thompson's reflections on "knowledge filtration" in [CT99] p. 189 et seq. and [Crem01] passim.

[32] See [Kuhn70] and [Maho76] for many striking descriptions of the follies of scientists. The locus classicus for this kind of critique of human frailty will be Bacon's famous critique of the idols in the first book of *Novum Organum.*

If we hold that the most glorious purpose of science is to help us find out about the mysteries in nature and to uncover truths – or even the truth – about nature, man, or whatever topic studied – rather than being just an instrument for practical purposes, a power-structure producing 'socially constructed realities', an inane attempt to create a grand *meta-récit,* or, a set of contagious Dawkinian 'memes' – the above gravamina will indeed be cumbersome.[33] One does not need to disavow or deprecate current scientific practices to recognise that there is, *pari passu* with the well-known trails and tracks, a need to find other paths, start from other points of departure, try to cast differently coloured light on things from new points of view. A classical path towards tempering fragmentation, weakening dogmatism, and possibly making us a little less liable to the infatuations of human nature goes through the study of history, the arts, religion, philosophy, etc., in short the humanities. However imperfect the result, a humble ambition to invigorate (or at least garnish) the present work by some fruits gleaned from the lush gardens where such studies are pursued has also been guiding me during the toils of authoring the present work.

In the humanities – where the expensive equipment and strictly organised missions typical of the sciences tend to play little part –, a communal temper is generally thought little of, independence, distinctive individuality, and learned reclusiveness[34] are valued highly, and a critical, sceptical historicism provides the predominating mode of thought, although, alas, occasional fits of academic feudalism as well as the natural human tendencies to emulate what one admires, find support in communities, cliques and cenacles, and succumb to fads and fashions – for fear of appearing behind the times, if nothing else – work homogenisation and hebetation also here. However, such tendencies seem more likely to meet with incredulity and suspicion than in the sciences, and in the main, I believe, will prevail to a significantly lesser degree. Notably, conferencing tends to be practised much more sparsely, as publishing is primarily done in books and journals, and writing – including thesis writing – is not only a way to publish "results", but also – and sometimes foremost – a labour of – *sit venia verbo* – self-development and self-expression, to which much effort is devoted and considerable attention paid.

There is of course a flip-side of all this individualism as well, e.g. in a marked liability to such *personal* faults and foibles as pride, snobbism, name-dropping, ostentation, and arrogance, to say nothing of ill-tempered controversies, acrimonious *ad hominem* attacks, and suchlike. Although annoying at times, it may be argued

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[33] See below p. 317 and 455 for discussions of the troublesome relationship between truth and science. Cf. also [Braw00].

[34] For instance, the idea of scholarship as a "sacred vocation" suggested in [Peli84] or as a "sacrament" or "religious quest" of "mystical value" proposed in [Good45] seems very far from the prevalent ideas on what it implies to be a "scientist". [Mars97a] argues that there is a need for an explicitly "Christian scholarship" to countervail the strong anti-Christian – and anti-religious – bias in current Academe. Unfortunately, he and some other advocates of such a religiously informed scholarship seem to restrict the need for it to the humanities, thereby implicitly lending credence to the vacuous myth that research in the sciences and technology is religiously and ethically neutral. In contrast, Kristo Ivanov at the University of Umeå in Sweden has, from a Christian-Catholic starting-point, supplemented by various other sources of inspiration, such as Churchman's systems approach (see [West71b] and [West79]), the Swedish philosopher Tage Lindbom's perennialist writings, C. G. Jung's analytical psychology, and the Jesuit philosopher and theologian Cyril d'Arcy's writings (see [Ivan93b]), advocated the need for spiritual, philosophical, and ethical reflection in computer and information science in numerous thought-provoking studies, including [Ivan80], [Ivan91a-b], [Ivan92], [Ivan93a-b], [Ivan95], [Ivan96], [Ivan97], [Ivan00], and [Ivan01] (additional materials are available at the web page http://www.informatik.umu.se/~kivanov). A very pessimistic Christian appraisal of present-day academe is provided in [Mali87]. See also [Petr98] and [Petr00] p. 7 for a discussion of Othmar Spann's plea for the necessity of spiritual experience in scholars and the implementation of this programme by the scholars in the tradition of "philosophical sociology" in Austria and Germany.

In [Yate67] (cf. also [Yate64] p. 144 et seqq.), Frances Yates offers some interesting observations on how the renaissance magus developed into the gentlemanly scientist of the late 17th century. She summarised her views on the relationship between Renaissance magic and science thus in [Yate64] p. 155 et seq.: "The Greeks with their first class mathematical and scientific brains made many discoveries in mechanics and other applied sciences but they never took whole-heartedly, with all their powers, the momentous step which western man took at the beginning of the modern period of crossing the bridge between the theoretical and practical, of going all out to apply knowledge to produce operations. Why was this? It was basically a matter of the will. Fundamentally, the Greeks did not *want* to operate. They regarded operations as base and mechanical, a degeneration from the only occupation worthy of the dignity of man, pure rational and philosophical speculation. The Middle Ages carried on this attitude in the form that theology is the crown of philosophy and the true end of man is contemplation; any wish to operate can only be inspired by the devil. Quite apart from the question of whether Renaissance magic could, or could not, lead on to genuinely scientific procedures, the real function of the Renaissance Magus in relation to the modern period (or so I see it) is that he changed the will. It was now dignified and important for man to operate; it was also religious and not contrary to the will of God that man, the great miracle, should exert his powers. It was this basic psychological reorientation towards a direction of the will which was neither Greek nor mediaeval in spirit, which made all the difference." Cf. also [McKn89], [Wals90] p. 109 et seqq., [Coud99] p. 334 et seqq., and [Thom78] p. 770 et seqq. [King95] p. 295 argues that the ancestor of the (original Persian) magus is the shaman, so, granted that we accept his arguments, one might pursue the thread of descent leading from the shaman of old to today's scientist; indeed, it may be an amusing pastime to meditate on the points of similarity between these two vocations. [BenD71] attempts to track down the development of the professional rôle of the "scientist".

that insofar as these perturbations are primarily limited to individuals, they, in most cases, tend to be less calamitous than the errors that pertain to research groups or whole communities. Much has been written on the different characters of the 'two cultures' and their respective virtues and vices, both before and after the famous Rede lecture in 1959, in which C. P. Snow coined this catch phrase[35], and many have urged upon the need to overcome the gulf by various interdisciplinary approaches. In computing, there has in fact been considerable interaction and cross-fertilisation of this kind for very long, giving birth to a number of highly notable developments, most spectacularly perhaps in user interface technology, but also in some other demesnes.[36]

As the perceptive reader will not fail to note, the form and content of the present study is suffused with strong influences from the classicist, scholarly, and hermeneutic traditions rather than the *Denkstile* usually preponderant in the writings of computer scientists. For one thing, the explanatory models brought to bear and the ways of reasoning leaned on will be illumined and guided by a lodestar that glows at least as much with the hue of Dilthey's and Weber's historically-descriptive and interpretative ***verstehen*** as with that of the hypothetico-deductive styles of ***erklären*** customary in the sciences.[37] In particular, the outlook, style, and approach of the present study will have been heavily influenced by two mistresses, whom I have kept from of old, viz. ***classical philology*** and ***the history of ideas,***[38] the latter understood in the broadest possible way as comprising also the history of theology, religion, culture, philosophy, science, and technology. The "hermeneutics" that inspirits this work consequently owes only little to the latter-day hermeneutics in the tradition of Heidegger, Gadamer, Habermas, Ricœur, and others, but more to the traditional varieties harnessed by classical philologists and the exegetes of holy texts.[39] The influence of the former variety shows in the attempts to elucidate

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[35] See [Snow98], to which a very readable introduction by Stefan Collini has been added. In his afterthoughts from 1963 (id. op, p. 70 et seq.), Snow thought he saw a 'third culture' about to take form betwixt and between the existing two in disciplines such as social history. Indeed, on a closer look the number of cultures will possibly proliferate ad infinitum; concepts such as Snow's two (or three) cultures, which are what Max Weber called ideal types, of course always have a good deal of arbitrariness about them. See also [Feye87] p. 1 et seqq. for some spirited strictures against the notion of a crisis triggered by the split between the two cultures and [Barz64] p. 9 et seqq. for a scintillating meditation on the unity of modern 'scientific culture' and the largely unfortunate ramifications of the 'specialism' on which it rests. [Aesc98] p. 58 et seqq. interestingly contrasts the anti-scientistic ideas of Snow's foremost antagonist F. R. Leavis with those of C. S. Lewis: Whereas Leavis wanted to combat scientism, "Techno-Benthamism", and aesthetic nihilism with a secularist "religion of culture" in the spirit of Matthew Arnold, C. S. Lewis based his opposition to the scientist "abolition of man" and "futilitarianism" on classical-Christian theism and the ***philosophia perennis*** of wisdom and ethical insight traded down through the ages by the great philosophers, metaphysicians, and moral and religious teachers.

[36] Besides the inspiration provided by Piaget's developmental psychology for the early work on graphical user interfaces and the ***Smalltalk*** language, other notable examples of synergies that immediately come to mind include the vigorous interactions between philosophy, cognitive science, and artificial intelligence, the importance of the visions of the humanist scholars Licklider, McLuhan, and Nelson for the development of the ***Internet*** and related technologies such as hypertext, Kruger's work on artificial reality and art and Jaron Lanier's on virtual reality, the impact of Chomsky's generative linguistics on compiler theory, the adaptation of the architect Christopher Alexander's design patterns to software engineering, and the impetus provided by Heidegger's philosophy for the formation of the agenda of ubiquitous computing. Many other examples can certainly be adduced. [Ivan91] provides an interesting critical study of the idea of "humanistic computer science".

[37] See [Dilt97] and [Webe95] p. 79 et seqq.

[38] A thought-provoking snippet of criticism of the ideohistorical approach is found in [Voeg96] p. 78, where Eric Voegelin comments on his own attempt to write a history of political ideas: "Ideas turned out to be a secondary conceptual development, beginning with the Stoics, intensified in the High Middle Ages, and radically unfolding since the eighteenth century. Ideas transform symbols, which express experiences, into concepts–which are assumed to refer to a reality other than the reality experienced. And this reality other than the reality experienced does not exist. Hence, ideas are liable to deform the truth of the experiences and their symbolization." Voegelin originally intended his magnum opus *Order and History* [Voeg56] as a history of "experience and symbolization", although he later had to revise his plans substantially in order to make this daunting project a little more tractable. Cf. also [Braw94b] p. 12 et seqq. for some similar reflections. Although the history of ideas as an academic pursuit is of recent origin, it was prefigured by various other attempts to make sense of intellectual history. For one thing, already in Antiquity the Christian heresiologists, such as Irenaeus, Epiphanius, and most notably Hippolytus, set out to trace contemporary (heretical) ideas from their sources in Greek philosophy and elsewhere. Another group of proto-historians of ideas was the ancient doxographers (see [Diel65]).

[39] [EHLM+77] provides one reasonable introduction to modern hermeneutics together with a pick of texts. Attempts to bring modern hermeneutics to bear on computer-related topics include [WF87], [MHD87], and [Coyn95a]. In [Mark87], Gyorgy Markus, having attempted to lay bare through a delicate hermeneutic analysis the rigid cultural organisation of norms and forms that governs scientific practice and writing and allegedly endows the sciences with "such an ease of hermeneutical achievements", somewhat paradoxically expresses utter pessimism (partly based on Latour's and Woolgar's findings in [LW86]) about the feasibility of an alternative, hermeneutically tempered approach to science (p. 9): "Philosophers of science may convincingly destroy the idea of an ideally sharp and unambiguous language of physics; historians of science may discover that in all the great disputes of the field – from the reception of the Copernican theory to that of quantum mechanics – the adversaries not only regularly misunderstood each other, but these misunderstandings also played a constitutive role since they polemically influenced the way the concerned theories actually developed; "ethnomethodologists" of laboratory life … can demonstrate that already simple "experimental reports" are underdetermined in their meaning and therefore, as a

through comment, interpretation, and historical sketches, whereas that of the latter has leavened my account in the form of a conviction that that there are profound mysteries and different planes of interpretation, not only in the texts of sacred writs, but also in the books of nature and history and in the feats and artefacts of human creativity, awaiting to be uncovered by a deeper reading and analysis than can be achieved by the one-dimensional approaches favoured by the proponents of the waste flatlands of modernity or the deceitful mirages of post-modernity.[40]

As shown by Kuhn and the sociologists of science, there is built into the workings of today's science a kind of institutionalised deceitfulness, which is the upshot of the systematic disregard and denial of anomalies, the dogmatic espousal of certain metaphysical and other presuppositions, and the irrational inner workings of science. Together these factors lead to a kind of tyranny of the probable, which, if not true, however just obscures and ultimately ousts the truth. In the intense debate that followed upon Kuhn's exposure of the ethical decrepitude of present-day science, there were, besides the shrill scientistic objections and vindications of the status quo of science, also a few brave thinkers who ventured to suggest remedies. In particular, Paul Feyerabend's plea for a more pluralistic science, where the borderlines between a scientific discipline, its history, and its philosophy are blurred, pointed in a promising direction. He outlines this suggested novel approach thus:[41]

> *A scientist who is interested in maximal empirical content, and who wants to understand as many aspects of his theory as possible, will adopt a pluralistic methodology, he will compare theories with other theories rather than with 'experience', 'data', or 'facts', and he will try to improve rather than discard the views that appear to lose in the competition. For the alternatives, which he needs to keep the contest going, may be taken from the past as well. As a matter of fact, they may be taken from wherever one is able to find them – from ancient myths and modern prejudices; from the lucubrations of experts and from the fantasies of cranks. The whole history of a subject is utilized in the attempt to improve its most recent and most 'advanced' stage. The separation between the history of science, its philosophy and the science itself dissolves into thin air and so does the separation between science and non-science.*

Unfortunately, the path of a pluralistic, less dogmatic science suggested by Feyerabend has largely become the road not taken by scientists, who since rather have tended to grow increasingly dogmatic. For the present author, Feyerabend's programme has, however, been a source of some inspiration, although I will later argue that it needs to be broadened in various ways. For example, I would contend that "specialism", i.e. the present over-compartmentalisation of knowledge, needs to be somehow countered and overcome, that the Cartesian division of reality into an objective and a subjective portion has turned out to be a disastrous mistake, that a much greater openness in science as to metaphysical, theological, and ethical issues is sorely needed, and that the systematic study of "anomalies" should be encouraged, as these, I believe, can help us break the tyranny of the probable in order to proceed towards truth or, perhaps rather, regain a truth lost during the pursuit of an increasingly ideologised and truth-occluding "science". Applied to computer science, this programme would imply that in order to find out the truth about the computer we cannot just leave aside history, philosophy, theology, metaphysics, etc. and focus on the purely technical or mathematical. On the contrary, we must ad-

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rule and without some additional conditions, cannot be replicated even by the expert reader – despite all these criticisms, the "hermeneutical naïveté" of the natural sciences persists, because it "works"." Considering the gravamina mentioned, it seems justified to ask if this "hermeneutical naïveté", although it perhaps "works", really *works well!*

Judging from the case of computer science, I disagree with his conclusions and rather contend that a philosophically, hermeneutically, and historically tempered approach to science may be highly invigorating and inspire new perspectives and new, very fruitful research directions. For one thing, the subcultures of computer science where such pluralism is fostered and some kind of hermeneutic or scholarly perspective taken advantage of seem in the main, I believe, to develop in at least as interesting and promising ways as those dominated by a more traditional, scientistic-positivistic mind-set.

On the classical four-fold (historical, tropological, allegorical, and anagogic) way of interpreting the Bible, see [Luba59]. Similar hermeneutical systems are found in the Jewish, Moslem, and Vedic exegetical traditions. On the exegesis of Homer, see [Lamb89]. Cf. also [Cohe66] p. 99 et seqq.

[40] The historical fortunes of the idea of the world as a text capable of interpretation are traced in [Blum99a]. Cf. also [Howe02] and [McLu62] p. 186 et seqq.

[41] See [Feye93] p. 33 et seq.

dress first things first, which is to say that in order to find out the truth about computing, it will be necessary to first pursue the truth about technology and science, which in turn implies that we also need to pursue the truth about history, cosmos, man, being, and God.

> *We undoubtedly get the short end of the stick in confrontations with hardware people because they are the industrialists and we are the crofters.*
>
> *Douglas McIlroy (at the NATO software engineering conference in Garmisch 1968)*[42]

The famous *NATO* conference held in Garmisch in October 1968 gave birth to three very unlike children, to wit the ugly and evil hydra *the software crisis* and the two handsome infants *software engineering* and *software components*.[43] These sibling notions have ever since remained forged together – the handsome ones as comrades in arms bravely fighting an unending combat against the former, seemingly invincible, ugly and utterly execrable hydra.

In this chapter, we will take a closer look at the *software components* McIlroy envisioned as a means to foster better ways of building software and *eo ipso* counter the *software crisis* and try to outline what has come out of his now more than 30 years old seminal idea. Firstly, though only briefly, I will discuss the backdrop of the component idea, "the software crisis", which, albeit interpreted quite differently by different observers, is widely held to remain a major problem in software development today no less than in 1968. Secondly, I will ask what a component really is. As we will see upon inspection of some suggested answers to this seemingly innocent question, the concept of a "software component" can be defined in different ways. In fact, the component idea has been claimed as a key feature of quite dissimilar software technologies, including some varieties of reuse-oriented software engineering, object-oriented programming, various varieties of "visual programming", and module- or package- oriented programming languages such as Modula and Ada, but has also lately been staked off as a domain of its own, occasionally referred to as *component-oriented programming (COP)*. Thirdly, I will try to reduce the prevalent conceptual confusion by taking a look at the historical background of the different understandings of the component idea. Fourthly, a bird's eye-view of today's three great "component and distributed objects technologies", *Microsoft's COM/.NET, OMG's CORBA,* and *Sun's JavaBeans/Enterprise JavaBeans* will be provided. The emphasis will be on the – rather grubby – infrastructure technologies, which provide the technical foundation for software componentry, rather than on the lofty heights of components *per se* or the even more exalted Elysian fields of component-oriented programming. Finally, I will round off the discussion by some compendious musings on the current state of the field.

This chapter is intended as a *cursory* survey of the topic of distributed objects and components, and, by necessity, it has only been possible to scratch the surface of such a vast subject, where even introductory texts often tend to become extremely bulky. Much here is definitely more laconic than I would like it to be, and the whole of it would indeed benefit from further polishing, but time, that intransigent old Scrooge, allowed nothing such.

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[42] [McIl68] p. 89.

[43] [Maho90] p. 326 discusses the origin of the term *software engineering* and states that Douglas Ross in the interview [Ross85] claimed to have given courses on *software engineering* already in the 50s. But what Ross actually says in this interview (in p. 80) is that he taught such a course in 1968. [Gord68] attributes the term to a talk by J. Presper Eckert at the *Fall Joint Computer Conference* in 1965, although some doubt is cast on this attribution by [Maho90] loc. cit. According to [McIl98], the title of the *NATO* conference was settled by higher *NATO* authorities and the term *software engineering* probably invented during the *NATO* proposal process.

1.1 SOFTWARE COMPONENTS AND THE SOFTWARE CRISIS

> *Unlike the hardware industry, which has organized itself into a fully elaborated rainforest of mutually interdependent structure of production trees, the software industry remains stuck in the unicellular, bacterial stage of the primordial ooze.*
>
> *Brad Cox*[44]

Much of the current interest in *software components* stems from a belief that components may present *the* solution to the *software crisis,* which was beginning to be more widely felt during the late 1960s, as the use of computers rapidly spread throughout Western society. In fact, the three terms *software engineering, software crisis,* and *software component* all apparently descend from the very same *NATO* conference on *software engineering,* held in Garmisch in October 1968,[45] at which mass produced *software components* were suggested by M. D. McIlroy as a remedy for the *software crisis.*[46]

Although many proposals about how to come to terms with the software crisis have been made since the mid-60s, the state of affairs in software construction has hardly improved radically. In an often-cited report presented by *the Standish Group* in 1995, the success rate of 8380 software projects in the United States was examined. Among these projects, no less than 31% were cancelled without any result whatsoever, 53% were finished, but exceeded time and budget limitations and did not satisfy the initial requirement specifications, and only 16% were brought to an end successfully.[47] According to the same report, about 250 billion dollars are spent each year on approximately 175.000 software projects in the U.S. only. Things are hardly very much different in the rest of the world[48], and, consequently, the total amount of money squandered on the construction of defective or useless software will be appalling.

Lately, software development has undergone something of a complexity boom, precipitated by the introduction of new technologies such as graphical user interfaces, multi-layered client/server computing, and networked and distributed, Internet-compatible system architectures. Simultaneously, *time-to-market* has become increasingly important, largely because of the rapid development of what is considered the state of the art in user interface design and the incessant feature war between competing products. If a software product is delayed, it will often not only cause unwanted expenses and lost market shares, but may as well suffer the sinister fate of "death on arrival".

It is often said – usually with a gesture of resignation – that software development is so extraordinarily complex. True as this may be, this is certainly also the case for many other branches of engineering, from which we have been accustomed to expect better results than from software construction. The development of cars, aeroplanes, ships, and houses are all very complex; nevertheless such construction efforts are mostly handled with excellent results.

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[44] [Cox95]

[45] [NR69]. See also chapter 2 of [Grin96].

[46] See [McIl68].

[47] [Stan95]. Unfortunately [Stan95] gives no details about the programming languages, tools, and technologies used in the projects surveyed. The analysis revolves around success factors such as user involvement, management support, distinct requirement specifications, proper planning, realistic expectations, use of milestones, staff competence, etc. The yearly updates of the *Chaos* report are not made public by the *Standish Group,* although they can be purchased for a substantial sum of money (see http://www.standishgroup.com), but the results from the *Chaos'97* report are cited in [Jame97] and [John99c] as 40% total failures, 27% successful projects, and 33% projects, which were delivered late, over budget, or with reduced functionality ("challenged projects"), whereas [John99c] states the results of the 1998 survey (i.e. the *Chaos'99* report) as 28% failures, 26% success stories, and 46% challenged projects and also estimates that $275 billion are spent each year in the U.S. on software development projects. Additionally, [Pise02] cites the results of the *Chaos 2000* survey as 23% failed, 28% successful, and 49% challenged projects. [Zveg98] questions the validity of the above estimates. [Cox86] p. 4 cites a 1979 *GAO* investigation of some U.S. federal software projects. Of these, 47% were paid for, but not delivered, 29% were delivered, but never used, 19% were abandoned or reworked, 3% used after change, and less than 2% used as delivered. As pointed out in [Blum92] p. 69 et seqq., the projects surveyed in the *GAO* report were, however, problem cases, not normal projects. A plethora of software "crash stories" is recounted in [Gibb94], [Joch95], [Coll97], [Flow96], and [Glas98]. Cf. also [Jone95b].

[48] Cf. [Coma], where Christine Comaford refers to an investigation performed by *Compuware* in 1995 of 70 European software projects, by and large confirming the notion that European software projects perform comparably with American.

One may well ask what makes software construction so different from other branches of engineering. Some important points of difference may be cited:[49]

- Firstly, notwithstanding software reuse having been in the limelight, particularly in *Ada* and object-oriented circles, for long[50], software construction remains essentially *monolithic*. Presently, reuse will be widely taken advantage of only within very limited segments of software development: *GUI* frameworks[51], class and function libraries for elementary data structures like linked lists, binary search trees, etc. and other low-level functionality, mathematical function libraries, and *ActiveX* and *JavaBeans* widgets will be the most common examples.[52] Thus, every new software project tends to start more or less from scratch, whereas in other complex types of construction, e.g. of computer hardware, electronics, aeroplanes, cars, or ships, the engineer will start the design process at a high level, working with a large number of ready-to-use, frequently even standardised, elements or components, which make complexity manageable by *encapsulation*.[53]

- Secondly, software construction lacks the *production chains* typical of more mature areas of engineering, where at each step in the chain components may be bought from a number of providers, which compete on a free market. This lack of production chains is a consequence – as well as a cause – of the monolithic ethos of software construction.

- The most fundamental reason why componentised construction has not materialised within the realm of software development, although its benefits have been widely recognised for a long time, may however be the difficulties in finding a rational way of charging for encapsulated pieces of software, these being immaterial, easily replicated pieces of programming or binary code rather than concrete, physical components, to which easily a per-unit price can be affixed.[54]

1.1.1 COMPONENTS – A PANACEA?

Software component technology may be construed as an attempt to tackle complexity, the core problem of software development being at the very root of the *software crisis*, by enlisting the help of the *component* con-

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[49] It goes without saying that the reasons for the failure of software projects are often complex and may differ widely. Technology is only one aspect of large software endeavours, and very often failure will be a consequence of non-technical, e.g. organisational or managerial, failings. Nevertheless, technology determines the rules projects have to play by. For one thing, the use of inadequate technology, which requires hordes of programmers working on low-level problems, may bloat projects to the size where they become prone to all kinds of organisational and communicative troubles.

[50] The intense interest in software reuse beginning in the mid-80s was largely kindled by the 1983 ITT *Workshop on Reusability in Programming* and much fomented by the *U.S. Department of Defense STARS* effort. See below p. 35.

[51] Although very much in vogue presently, the use of *GUI* application frameworks is haunted by a number of serious problems. Firstly, such frameworks operate through a kind of structural reuse, implying a very inadequate encapsulation of the functionality of the framework. Consequently, the application code will become tightly coupled to the framework, not to say totally entangled with it, making it exceedingly difficult or outright impossible to change frameworks or combine pieces from one framework with those of others. Secondly, application frameworks have a very large *surface area* (*surface area* is defined by [CN91] p. 17 as the number of things that must be understood and properly dealt with for one programmer's code to function correctly in combination with another's) and, hence, place a large cognitive strain on their users, who will need much of both time and talent to be able to attain mastery of these behemoths. See below p. 254.

[52] Exceptions do exist, e.g. the Japanese "software factories" mentioned by [Trac95] p. 131 et seqq. (see below p. 34). More success stories and some interesting statistics are presented by [JGJ97] p. 6 et seqq.

[53] Considering that software construction spans a much wider domain than each of the branches of physical construction enumerated above – or rather a multiplicity of such domains –, one might be tempted to believe that the reason why software projects tend to start from scratch is that they usually attack new problems. This might be true with reference to the project members or even the organisation initiating the project, but observed from a less parochial point of view, software projects very seldom concern entirely new problem areas. Although project members never have developed a word processor or an accounting system before, certainly others have! The project would, beyond doubt, be far better off, if it could draw on the results of some of these predecessors by using and customising *COTS* (*commercial off-the-shelf*) components that implement at least parts of a word processor or an accounting system – not to mention all those *COTS* components useful across different domains.

[54] See below p. 35. See [Cox95] and [Cox97]. This is also the main thesis of Brad Cox' captivating book [Cox96].

cept, which paved the way for the impressive evolution of computer hardware during the last few decades. As pointed out by Brad Cox and Andrew Novobilski in their book on object-oriented programming, the rapid, uninterrupted rate of progress in computer hardware as described by Moore's law[55] dwarfs the humble steps forward that, after all, have been made in software construction as well:[56]

> *One of its many implications is that during the same period that my productivity has been growing arithmetically with each improvement in programming language technology, the productivity of my friends in the hardware industry has been growing geometrically as the capability of the building blocks that they work with doubled each year for twenty years. My productivity certainly improved in moving from assembly language to FORTRAN to C to Lisp. But it certainly did not improve by a millionfold, as implied by Moore's law:*
>
> $2^{20} = 1{,}048{,}576$

The influence of ideas and concepts from the domain of hardware construction is pervasive in the discussion and terminology prevalent within the software component area. Already McIlroy, in his seminal 1968 speech, contrasted the industrialist attitude of the hardware people with the amateurism of the "crofters" active in software development. Ever since, hardware engineering has retained its position in the discourse on software components as the paragon of virtue to be emulated by the software "crofters". In the somewhat overheated lingo of the field, some of the core ideas of software component technology may, for instance, be outlined like this: [57]

> *A component is … a software IC. Frameworks are the boards we plug these components into. The object bus provides the backplane. Families of software ICs that play together are called suites. You should be able to purchase your software ICs—or components—through standard part catalogs.*

A few years ago many proponents of software component technology aired expectations about an imminent breakthrough in software construction brought about by the adoption of this new technology. For example, Brad Cox described the *software crisis* in terms of a prolonged Kuhnian paradigm crisis and envisioned component-oriented programming as the new paradigm coming out of this crisis.[58] In a number of books and articles, amply illustrated with hilarious cartoons of Martian computer scientists, Robert Orfali, Dan Harkey, and Jeri Edwards described components that co-operate in suites as the foundation of the "intergalactic client/server era", which, they held, was then about to succeed the *Ethernet* client/server epoch.[59] And in a much-praised tome on software reuse, Ivar Jacobson, Martin Griss, and Patrik Jonsson described components as "fueling a revolution in application development" and made them the kingpin of their own reuse methodology.[60] In fact, most authors discussing software components seem to harbour great expectations about them – if they did not, there would, perhaps, be little point in writing about them at all.[61] What all this boils down to

[55] Formulated by Gordon Moore in 1964, this "law" states that the logic density of silicon integrated circuits will double every year. Actually, this was only true until 1972, when the doubling period increased to 18 months. See [BG97] p. 8.

[56] [CN91] p. 26 et seq

[57] [OHE96b] p. 32 et seq. Cf. also [JCJÖ92] p. 291, [CN91] p. 26 et seq., [Digr95], [Berg97], [Broc95] p. 95, and [Chap96b] p. 14 et seq. The hardware-software analogy is criticised in [Kara98d].

[58] [Cox90a-b] and [CN91] p. iv et seq.

[59] E.g. [OHE96b] p. 17 et seqq.

[60] [JGJ97] p. 7.

[61] Criticisms of the claims made by the proponents of component technology seem to be virtually non-existing. One passage of animadversion could, however, be found in [Trac95] p. 118. Here Will Tracz presents his own objections – made back in 1987 as a reply to Brad Cox – to the "myth" that "designing software from reusable parts is like designing hardware using integrated circuits". On the next page he, however, seems to retract his former myth debunking attempt and in [Trac97] he wholeheartedly embraces the idea that *JavaBeans* will make it possible for developers to "realize huge increases in productivity and quality by just "using" the components like COTS". Likewise, [OCal99] criticises the belief in components as a "silver bullet" by citing Frederick Brooks' famous reflections in [Broo87] on

is, however, the rather humble hope that software construction one day will become as controlled and predictable as other engineering disciplines.

Great expectations have been attached to many new software technologies before like structured, modularised, and object-oriented programming, CASE, 4GL languages, software engineering, artificial intelligence, various "methods", or even to mathematical formalism and programme proofs.[62] Many of these approaches have in one respect or other implied significant steps forward in the way computer programmes are designed and built, although their impact on the *software crisis* has at best been limited. There are, nevertheless, some good reasons to believe that components are not yet another passing fancy, provided a number of conditions are fulfilled.

Firstly, software component technology really seems to address the correct problems, viz. the complexity of software development and the lack of software production chains, and addressing the right problem should at the very least be the first step towards diminishing it. Secondly, the promising results brought about by the "forms-based programming paradigm" together with the *VBX/OCX/ActiveX* component technology as implemented in *Microsoft's Visual Basic* and a number of other *rapid application development* tools for the *Windows* environment seem to substantiate some of the claims made for components. Moreover, a not entirely rudimentary market for *VBX/OCX/ActiveX* components has actually begun to materialise.[63]

For a substantial component market to emerge and components to become the zephyr that tosses software construction out of its current doldrums, a number of conditions must evidently be satisfied:

- A standard for components is needed. Today, there are two main candidates for such a standard, *Microsoft's COM/.NET* and *Sun's JavaBeans,* whereas, after the demise of the *OpenDoc* effort in early 1997, a third contender, the *Object Management Group's CORBA* technology, primarily targets *distributed objects,* which can be viewed as a special variety of server-side components. None of the mentioned technologies is currently a formal *de jure* standard, although some aspects of *CORBA* have been adopted as ISO standards.[64]

- There must also be a widely available and accepted component infrastructure, complying with the above standard. Today, such infrastructures are provided by *Microsoft's COM/.NET* and *Sun's Java 2 Platform, Enterprise Edition (J2EE).*

- Standards or widely accepted specifications defining the interfaces of frequently needed components, which may be domain-specific or shared across multiple domains, will be required as well. Much work has been done to define such interfaces within *OMG,* the *Microsoft* sphere, and a plethora of standardisation bodies.

- Good, visual programmer's tools, which make it easy to find, manage, and glue components together, must be available. This requirement is at least partly met by modern component-based *RAD* environments.

- Last, but not least, it must be possible for component developers to earn a living by their trade, i.e. a rational way of charging for component usage must be devised, thwarting the dire consequences of components being immaterial binary goods that might easily be

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complexity as an essential quality of software development, but actually Brooks, commenting in p. 210 of the anniversary edition of *The Mythical Man-Month* [Broo95] on one of Cox' silver bullet articles [Cox90a], admits that the component approach is "an attack on the conceptual essence of the problem". For some discerning afterthoughts on *Stepstone's* attempts to create technology and a market for *software-ICs*, see [Love93] p. 217 et seq. Cf. also [Cox96] p. 41 et seqq., [Kara98d], [HM83], and [Booc87] p. 6.

[62] On the latter, see [Hoar96].

[63] According to the *Giga Information Group,* the *ActiveX* market generated more than $240 million in revenues 1996, $410 million in 1997, and $670 million in 1998. See [Micr96d], [Micr97a], and [Micr98o]. [LH02] provides a recent survey of some "composition environments for deployable software components".

[64] See below p. 75.

copied. This nut may well turn out to be a hard one to crack, and the cardinal importance of cracking it is only seldom realised.[65]

1.1.2 THE TECHNOLOGICAL DRIVERS

In addition to the rather ambitious desire to come to terms with the software crisis, several other technological needs and currents have been instrumental in the emergence of component technology. In fact, component technology – or important aspects of it – could largely be understood as a response to a number of problems and trends in software construction:

- the seemingly mundane need for interoperable binary object libraries, where binary objects, regardless of the programming language taken advantage of to write them and the compiler used to compile them, may be utilised from any programme without time-consuming re-compilations of source code – that might not even be available[66]

- the need for infrastructures for distributed computing and distributed objects as a consequence of the success of client/server computing, reinforced and also fundamentally reshaped by the *Internet* boom and by the ideas about a world-wide "object bazaar"[67]

- the long-ranging trend from *application-centric* user interfaces towards a more object-oriented, *document-centric GUI*[68], where different types of data might be seamlessly integrated and directly manipulated by the user, implying a level of *GUI* integration for which a *compound document architecture* is a prerequisite – actually *compound documents* were originally the primary purpose of *Microsoft's OLE (Object Linking and Embedding),* the predecessor of *COM,* of which it still makes up a substantial part, as well as the research projects at *Data General* and *Hewlett-Packard,* from which was born the *Object Management Group*

Besides these technical issues, there are of course various "business" drivers of software componentry as well, such as the expectations about reduced costs, failure frequencies, and cycle times for software development. However, these objectives are largely tantamount to the struggle against the "software crisis" discussed in the previous section.

[65] Brad Cox, who has investigated this question in depth in a number of articles (see [Cox92], [Cox95], [Cox97], and [Cox02]) and in his book [Cox96], proposes that users should be charged when using components, not when acquiring them. This presupposes a *superdistributed* infrastructure, where all computing resources are inter-connected – a vision that may perhaps materialise, when *WWW*-connections become really omnipresent. In addition, a *micropayment* mechanism is needed, such as the *Millicent* protocol developed at *Digital Equipment*, providing for the charging for component use over the *WWW* without incurring an immense amount of overhead. On *Millicent,* see [Poun97b], [GMAG+95], and [Mana95]. Other kindred schemes are listed on the home page of the now defunct *W3C Ecommerce/Micropayment Activity* (see http://www.w3.org/ECommerce/Micropayments). Cf. also [Chi97].

[66] Cf. [Chap96b] p. 17 et seq. The want of a binary standard for objects written in different languages and the lacking link compatibility between compilers for one and the same language, such as *C++,* are major obstacles to the reuse of binary objects. Somewhat strangely, object-orientation – at least as implemented in *C++* and *Java*, the by far most popular object-oriented languages – has in practice often meant a step back as far as reuse is concerned when compared to the earlier reuse vehicle of statically or dynamically linked function libraries, usually written in the *C* language.

[67] See [BRMS+96] p. 99 et seqq.

[68] On this concept, see [Coll95].

1.2 WHAT IS A SOFTWARE COMPONENT TECHNOLOGY?

I will now try to cast some light on what software component technology is all about. Since technologies such as *COM, .NET* and *CORBA* are both complex and bulky and may be difficult to get a purchase on, I will start out by giving some examples of common application areas, before attempting to clarify what a "software component" is.

1.2.1 THE MAJOR APPLICATION AREAS

During the 90s, component technology grew into one of the cornerstones of software construction, but many of its proponents believe its prospects are considerably more auspicious than that, nay, that components will transform software developers from crofters into industrialists. Be that as it may, technologies like *COM (Component Object Model), COM+, .NET, OLE (Object Linking and Embedding),* and *ActiveX* from *Microsoft, CORBA (Common Object Request Broker Architecture)* from the *Object Management Group (OMG)*, or *RMI (Remote Method Invocation), JavaBeans,* and *Enterprise JavaBeans* from *JavaSoft* are about to become increasingly pervasive in all kinds of real-world software. An inventory of their most noteworthy uses will at least include:

- *Component-oriented programming:* For several years now, the method of choice for *rapid application development (RAD)* of *Windows GUI* programmes has been based on the employment of visual *VBX, OCX, ActiveX,* and lately also *.NET* controls. The programmer distributes such pre-built components on forms (i.e. windows) and controls their behaviour and appearance by assigning values to their *properties* and by attaching small chunks of event-handling code to them. Additionally, *bound* components tie on-screen data presentation directly to fields in the tables of a database, thereby simplifying *client/server* database programming significantly. The "forms-based programming style", made popular by *Microsoft's Visual Basic*[69]*,* is doubtless one of the most important factors behind the success of the *Windows* platform[70], cutting development times and costs radically as compared to more traditional development techniques.[71] There is a sizeable market for *ActiveX* components estimated by the *Giga Information Group* at $240 million in 1996[72], $410 million in 1997, and $670 million in 1998[73] and predicted in 1998 to expand to $3 billion by the year 2001[74], although it seems unlikely that this prediction was fulfilled. A wealth of *ActiveX* components is sold through various outlets, implementing a wide range of functionality.[75] Another

[69] It has been adopted in some other successful *Windows RAD* development tools such as *Borland's Delphi, Gupta's SQLWindows* and *Team Developer, Sybase's PowerBuilder,* and *Oracle's PowerObjects.*

[70] According to a September 1997 *Microsoft* press release [Micr97b], there were then more than 3 million *Visual Basic* developers in the world, amounting to more than 50% of all professional programmers at the time. The same source claims that there were 419 books about *Visual Basic*. In [Micr97a] the number of systems where *Microsoft's* component infrastructure *COM* is in use was estimated at 200 million. Out of these, *Windows95* accounts for 100 million and *Windows NT* for 7 million systems, whereas 16-bit *Windows* versions (3.1 and 3.11) will make up the remainder. How these estimates have been arrived at is not explained, and, of course, they should be taken with a fair pinch of salt. [Sess97a] reports that *Microsoft* in April 1997 ousted *IBM* from the position as the largest software company in the world in terms of revenues. Cf. also [Micr98 u].

[71] Additionally, this programming style has made possible new software development methods that offer a degree of predictability hitherto unknown. One example is the methodology created by Prof. John J. Donovan of MIT (cf. [Don94]). This method has been consistently used by *Cambridge Technology Partners,* a software consultant company founded by Donovan himself. This company claims that their time and cost estimates turn out to be reasonably correct in more than 90% of all cases, making it possible for them – as well as a number of epigones – to offer fixed prices in all their commissions. [McCo96] p. 515 et seqq. contains a discussion of *rapid development languages*. Cf. also [Mart91] and [Lint95].

[72] [Micr96d]

[73] [Micr98o]

[74] [Micr97a]

[75] Many of these can be purchased at http://www.componentsource.com. A quick perusal of some catalogues such as [Lins97] or [Lins02] as well as the ads in popular programmer's magazines and the survey article [Murd96b] will uncover *VBX/OCX/ActiveX* components, which implement just about everything from simple *GUI* widgets, like edit fields, buttons and bitmaps, to advanced utilities e.g. for modem- or ISDN communication, networking, fax, telephony, translation from text to speech, spell-checking, pattern-matching, tables and spreadsheets, database handling, time planning, calendars and Gantt schemes, imaging, scanning, OCR, multimedia (including sound, pictures, and video), business graphics, word processing, drawing and painting, CAD, file compression, report management, maps, bar codes, etc.

component marketplace, albeit certainly substantially smaller in revenues, has formed around Sun's *JavaBeans* and *Enterprise JavaBeans* technologies, and many minor and some blue chip players, including *IBM*[76], have been investing heavily in the development of bean components and tools for the construction and deployment of these.[77]

- *Compound documents:* The development of the infrastructures we now call component technologies was originally embarked upon in order to provide support for *compound documents,* i.e. documents where different types of data such as rich text, pictures, spreadsheets, multimedia presentations, etc. may be freely blended. As yet, the only widespread compound document architecture is *Microsoft's OLE (Object Linking and Embedding),* being an integral part of the *Windows* infrastructure since the early 90s and having a fair share in its success. The *Office* suite of products, being one of the chief factors behind *Microsoft's* triumphs, has largely gained its popularity because of the tight integration between the various products brought about by just compound document technology. Other compound document architectures are *OpenDoc* and *Fresco,* and *JavaBeans* will perhaps ultimately evolve towards support for at least some compound document features as well.[78]

- *Automation:* Many widely used applications include support for programmability through a *scripting language,* which lets an advanced user control the application by writing *script* programmes. Being part of compound document architectures such as *OLE* or *OpenDoc, automation* is a mechanism for the implementation of late-bound scripting languages, where methods are discovered and invoked dynamically at run-time. In the *Microsoft* version of automation, referred to as *OLE Automation* or just *Automation*, *automation servers,* i.e. applications supporting automation, provide various services through one or more *automation objects,* also known as *ActiveX objects,* which expose methods and properties to *automation controllers* through a special *dispatch interface* (or *dispinterface)* and may also be able to generate events.[79] For example, *Microsoft* supports *scripting* in its *Office* product suite through *Visual Basic for Applications (VBA),* which is advertised as the standard scripting language for *Windows* applications and has gained widespread popularity in the *Windows* world, whereas *Internet Explorer* provides support for the *VBScript* and *JScript* scripting languages. Likewise, a *CORBA Scripting Language* specification (also known as the *CORBAscripting* specification) has been adopted by *OMG.*[80] Scripting and compound document technology have fostered a new way of building software solutions rapidly, where the rich functionality of shrink-wrapped applications such as *Word* or *Excel* are taken advantage of through simple script programmes, which act as glue-like co-ordinators and integrators.

- *Programming language implementation:* The virtual machine *Microsoft* developed for its implementation of the *Java* language in the late 90s was based on *COM* and makes *Java* objects appear as *COM* objects, which may be used by any external client capable of handling these.[81] Conversely, any *COM* object may be accessed from a *Java* programme that executes in the *Microsoft Virtual Machine* just like an ordinary *Java* object is.[82] In fact, this kind of close

[76] On *IBM's* huge *SanFrancisco* framework, see footnote 500 on p. 115. Cf. also [Shel95l] and [Shel95m], where various "business objects" available for purchase are surveyed.

[77] See http://java.sun.com/products/javabeans/marketing.html.

[78] The plans for the *Edinburgh* release of *JavaBeans,* which was to include some compound document features, were quite vague and have not been implemented as yet. See [Mons97].

[79] As the *Automation* technology has evolved, the technical details have changed somewhat. In *.NET, Automation* has been altogether replaced by support for *Java*-style reflection.

[80] See [OMG01c]. Cf. also [Sieg02] and [OMG97e].

[81] See [Chap96b] p. 301 et seqq.

[82] By using *Java,* the *COM* programmer will gain a number of important benefits. Firstly, he is relieved of the tedious and error-prone *COM* reference counting – *Java's* garbage collection will handle that automatically for him. Secondly, *Java* supports the *COM* notion of objects having many interfaces and makes it possible to hide away the interface negotiation mechanism altogether. The *Java* virtual machine will automatically call *QueryInterface* and perform the necessary tests involved. For more information about *COM* reference counting and interface negotiation, see below p. 58. *Microsoft's* new *.NET* component infrastructure will make these boons available to any

integration with *COM* has for long been one of the main attractions of *Visual Basic* and similar *RAD* environments. The new *.NET* family of *Microsoft* languages and development environments will be even closer integrated with the new *.NET* component technology. Somewhat similarly, in the mid-90s *IBM* and *Metaware* offered *C++ DirectToSOM* compilers, which produced executables where objects were managed by *SOM (System Object Model), IBM's* now defunct object broker.[83]

- *Distributed client/server systems and business objects:* Object-oriented distributed systems – i.e. systems using *distributed objects* – can be built by taking advantage of any of a number of commercially available *CORBA (Common Object Request Broker Architecture)* object request brokers (often referred to simply as *ORBs*), such as *IONA's Orbix, Borland's VisiBroker,* or *IBM's ComponentBroker.*[84] In the early days, *CORBA*-compliant object brokers dominated this – still admittedly rather small[85] – market, but later they were getting increasing competition, for example from *Microsoft's* rival technologies *DCOM (Distributed Component Object Model), Remote Automation,* and the recent *.NET Remoting*[86]*,* and, for pure *Java* systems, the *Java RMI (Remote Method Invocation),* introduced in *JDK (Java Development Kit) 1.1*. The *CORBA* brokers and *Java RMI* have an edge over the *Microsoft* technologies in mixed environments, although versions of *DCOM* for various *UNIX* and other non-*Windows* platforms exist. One important application of distributed object technology is the development of object- or component-oriented middle layers in three-tier client/server designs. These middle layer objects are often referred to as *business objects,* since they typically correspond to real-world objects, which have some "business" significance.[87]

- *Database access:* Today, component technology is widely used for accessing databases and various other data stores. For example, *Microsoft's OLE DB, ActiveX Data Objects (ADO), Remote Data Service (RDS),* and *ADO.NET* offer *COM*- or *.NET*-based interfaces to relational databases and some other types of data stores, whereas the *CORBA Persistent State Service,* replacing the abortive *CORBA Persistent Object Service (POS),* is meant to provide similar *CORBA*-based interfacing to different kinds of databases and data stores.[88] It is also possible to use a relational or object-oriented database system as storage for *CORBA* objects by taking advantage of a special *object adapter.*[89] Such adapters have been developed that combine, for instance, *IONA's* object broker *Orbix* with the *ObjectStore* and *Versant Object-Oriented Database Management Systems (ODBMSs).*

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language that takes advantage of the *.NET Common Language Runtime (CLR)* and also supports many other interesting features, such as cross-language inheritance, standardised versioning, hierarchical namespaces, configurable code security, etc. (see [Plat02]).

[83] See [Hami96], [Hami97b], [HKMT95], and [Udel94a] p. 52. Cf. also [Haus97], [Grun97], [GH97a], and [Ober], discussing and documenting a "direct-to-*COM*" compiler for the *Oberon/Component Pascal* programming language.

[84] At http://www.corba.org/success.htm, is provided an impressive list of *CORBA* "success stories" from branches as diverse as aerospace and defense, banking and finance, chemical/petrochemical industry, consulting, education, electronic commerce, government, healthcare and insurance, human resources, manufacturing, publishing/multimedia, real estate, research, retail, software/hardware companies, telecommunications, transportation, and utilities. Cf. also [OMG97g].

[85] For a listing of *CORBA ORBs,* see http://www.cetus-links.org/oo_object_request_brokers.html. As per November 1997, more than 15,000 developer licenses of *IONA's Orbix* (on which, see [Bake97b]) were reported to have been shipped to over 2000 companies (see [IONA97]), and in 2002 the number of *IONA's* customers was reported to exceed 4,500 and its employees 800 (see [IONA02]). *Orbix* is probably the most widely used *ORB* currently, so this will give some idea about the size of the *CORBA ORB* market. Certainly, many, perhaps most, of these *ORB* licenses have, however, been purchased for experimental use only. In addition to the commercial *ORB* products, there are quite a few freeware *CORBA ORBs* available (see http://patriot.net/~tvalesky/freecorba.html).

[86] [BK96] is the *DCOM* specification. *Remote Automation* is a facility providing easy cross-machine access of *dispatch* and *dual interfaces*. It was introduced in *Visual Basic 4.0* and thus significantly preceded *DCOM* in time, although it uses the same basic mechanism for cross-machine communication, viz. *RPC*. Like automation itself, it was developed by the *Visual Basic* team and is primarily geared towards use from *Visual Basic*. See [Chap96b] p. 103 et seq.

[87] They also typically correspond to modelling and analysis objects as well as records in *DBMS* tables.

[88] See [OMG02f] and [Sieg00] p. 351 et seqq.

[89] Object adapters will be discussed below on p. 79.

- *Transaction processing: Transaction Processing Monitors* like *IBM's CICS* or *BEA's Tuxedo* have been used for transaction-intense on-line systems for a very long time. Of late, transaction monitors have started to merge with component and distributed object technology and the resulting hybrid products have been aptly labelled ***object monitors.***[90] Microsoft's *OLE Transactions,* for instance, provides a basic *COM*-based transaction service, which is used in *Microsoft Transaction Server (MTS)* to define and control transactions implemented by *COM+* middle layer components. The *OMG Transaction Service* (formerly known as the *Object Transaction Service, OTS)* provides a specification for a *CORBA*-based counterpart.[91] Some years ago, *BEA,* the provider of the leading *UNIX*-based transaction monitor *Tuxedo,* acquired *Digital's ObjectBroker* and integrated it with *Tuxedo* into its *WebLogic* product line*,* and there are several other products which combine specific *CORBA ORBs* and transaction processing monitors.[92] Furthermore, *Enterprise JavaBeans* endows middle-tier or server-side *JavaBeans* with transaction support based on the *Java Transaction Service (JTS),* a *Java* adaptation of *OMG's OTS*. Finally, the *CORBA Component Model (CCM,* also known as *CORBAcomponents)* specifies a language-independent, partly *Enterprise JavaBeans*-compatible container environment for transactional middleware components.[93]

- *Internet development:* The last few years many attempts to make distributed object and component technology an integral part of the *Internet* infrastructure and programming model have been made,[94] of which the *Java* programming language has largely been the pivot.[95] For instance, *Netscape,* the well-known provider of *Netscape Navigator* and other *Internet* products, long ago adopted the *JavaBeans* component model in its *Netscape ONE (Open Network Environment)* platform for "network-centric" and "crossware" application development.[96] Additionally, support for *OMG's Internet Inter-ORB Protocol (IIOP)* was included into *Netscape ONE*.[97] *IIOP* is a protocol originally developed in order to make different *CORBA* object brokers interoperate, and its support in *Netscape ONE* made it possible for *Java* applets to interoperate with *CORBA* objects. *Netscape* has also embedded the *Java*-version of

[90] There is a plethora of related terms, such as *object transaction server (OTS), object transaction monitor (OTM), object monitor, object manager, object engine,* or *applications server,* in more or less widespread use – see below p. 581 for an attempt at a clarification.

[91] See [OMG02g]

[92] For example, *IONA's OTM (Object Transaction Manager)* is based on the transaction processing technology of *Transarc,* and *Visigenic* and *Hitachi* have jointly developed the transaction-processing *ORB TPBroker*.

[93] See [OMG02b].

[94] This vision of the next generation of *Internet* is sometimes referred to as the *Object Web* (so [OH97b] p. 2 and p. 617 et seqq).

[95] The *world-wide web* is basically just a mammoth client/server system, where client web browsers like *Netscape Navigator* or *Microsoft's Internet Explorer* connect to web servers through the *RPC*-like protocol *HTTP (Hypertext Transfer Protocol)* in order to retrieve web pages encoded in *HTML (Hypertext Markup Language)*. *HTML* pages may contain embedded *applets,* i.e. simple components written in the object-oriented *Java* programming language. Applets are downloaded from web servers as *byte codes* that execute locally on the client machine in a *Java virtual machine,* which is part of the web browser. *Java's* rôle as applet programming language has made it the *Internet* programming language of choice and largely explains why so much labour has been spent on fitting *Java* together with distributed object and component technology.

[96] See [Nets97b], [Udel97], and [AN97]. *Netscape* has also developed a *BeanConnect* technology to make it possible for *JavaBeans* embedded in *HTML* pages to interoperate.

[97] See [Nets96] and [OMG96e]. The building blocks of *Netscape ONE* mentioned in [Nets96] include:

- *HTML* as the language for building web pages
- the *Java* programming and the *JavaScript* scripting language, both sharing the same *Java* object and messaging model
- *Netscape Internet Foundation Classes (IFC)* supporting various features not present in the base *Java* frameworks
- *Netscape ONE plug-in APIs* extending client as well as server functionality through binary components
- *LiveConnect* extending the *Java* object and messaging model to non-*Java* objects through the *Java Runtime Interface (JRI),* which supports local mappings of non-*Java* objects to the *LiveConnect/Java* object model, or through *IIOP,* which provides access to the remote interfaces of *CORBA* objects through ordinary *Java* interfaces
- various communication and collaboration protocols such as *HTTP, NNTP, SMTP, IMAP4,* and *POP3.*

Visigenic's CORBA-compliant object broker *VisiBroker*[98] in *Netscape Communicator* and ships both the *Java* and *C++* versions of *VisiBroker* together with *Netscape Enterprise Server.*[99] *Netscape* also supports *RMI,* thereby giving *Java* applets yet another way to interconnect with remote *Java* objects. Similarly, *Microsoft's Java* implementation, used in *Internet Explorer* and *Visual J++,* enables *Java* applets and objects to interact with local as well as remote *COM* objects transparently.[100] *Microsoft* has also accommodated a number of existing *COM/OLE* technologies to the *Internet,* imparting the *ActiveX* epithet to them as a token of this adaptation.[101] For example, *OLE Controls* were replaced by the *ActiveX Controls,* which were made considerably more lightweight than their predecessors in order to facilitate downloading over the *Internet. ActiveX Controls* are supported in *Internet Explorer* and have been promoted by *Microsoft* as a more flexible mobile-code alternative to *Java* applets.[102] *Internet Explorer* also supports *automation objects,* also known as *ActiveX objects,* which is a kind of *COM* objects exposing methods, properties, and events. Additionally, *Microsoft* has launched a plethora of new component types geared specifically towards the web, such as *Dynamic HTML (DHTML) scriptlets, [XML] scriptlets, HTML Components (HTCs), DHTML Behaviors,* and *Binary Behaviors. ActiveX Documents* and *ActiveX Scripting* adapt compound document technology and scripting facilities to an *Internet* browsing environment and are supplementary to *Microsoft's OLE Documents* and *Automation* technologies.[103] In contrast, *ActiveX Hyperlinks* implements an altogether new technology, adding support for hyperlinks and the browsing metaphor to *Internet* as well as ordinary applications, including e.g. the *Windows* shell and the *Explorer* file handling utility. Additionally, *Active Server Pages (ASP)* – now destined to be replaced by the new, but similar *ASP.NET* technology with its *ASP.NET controls* – is a *Microsoft* technology supported by *Microsoft's* web server *Internet Information Server (IIS),* facilitating the creation of server-side web pages written in *Dynamic HTML* and augmented by embedded scripts, which will be executed on the server and interact with *automation objects/ActiveX objects* (in this context sometimes also referred to as *Active Server Components, ASCs),* such, as for example, the aforementioned *ActiveX Data Objects (ADOs)* for database access.

The above inventory only contains some – admittedly very significant – examples of where component technology is currently used, but many others might come to mind as well, such as operating systems, domain interface standardisation, agents, etc. Certainly, component technology might be fruitfully applied to almost any domain within software construction, and it is currently on the verge of becoming ubiquitous.

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98 *VisiBroker* is supplemented by *Caffeine,* co-developed by *Netscape* and *Visigenic. Caffeine* simplifies *Java*-based *CORBA* programming by generating *CORBA IDL* stub and skeleton code automatically (these concepts will be explained below on p. 78) from *Java* interface definitions. It also provides *URL*-based naming support. Cf. [OH97b] p. 269 et seqq.

99 See [OH97a], [Nets97a], [Visi96], and [Visi97]. By the way, an "*ORBlet*" is an interesting variant of a *Java ORB* that may be downloaded – typically together with an applet – and executed as byte codes in a web browser, if not present in the browser already. Cf. [OH97b] p. 58. [MM97] p. 298 et seqq. understands *ORBlet* as a *Java* applet that contains *CORBA* stubs so as to be able to connect to remote *CORBA* applications. Apparently, the terminology is in a flux.

100 *Microsoft,* however, does not support *IIOP* and is markedly lukewarm about *RMI.* The lacking support for *RMI* (and *JNI,* the *Java Native Interface)* in *Microsoft's* implementation of *Java* was one of the main complaints lodged against *Microsoft* in the lawsuit filed by *Sun* in 1997 and finally settled in 2001. *Microsoft* later made available an implementation of *RMI* (and *JNI),* although in *Microsoft's* recent *.NET* version of *Java, Visual J#,* the support for *RMI* (and for *JNI* and *RNI,* the *Raw Native Interface)* has once again been removed. Serious concerns about *RMI* have been aired not only by *Microsoft,* but also by some *CORBA* advocates, e.g. [Curt97] and [OH97b] p. 240 et seq. To bring some relief to apprehensive *CORBA* supporters, *Sun* later added support for *IIOP* as a network transport for *RMI* (see [Sun97b]).

101 *Microsoft's* web technologies will be dealt with at considerable length on p. 535 et seqq. below.

102 *ActiveX Controls* have not gained widespread popularity on the web [LM97]. Lack of portability to non-*Microsoft* operating systems and wanting native support in *Netscape Navigator* – there is, however, a plug-in from *NCompass Labs* that adds support for *ActiveX Controls* to *Netscape* – as well as a much criticised security mechanism (based on trust verification, i.e. transmission of digital signatures and certificates to trust providers) are some problems that account for this. As for security, it is interesting to note that *Java* applets may also be freed of their usual *sandbox* restrictions by a trust mechanism very similar to the one used for *ActiveX* components. Such potentially dangerous applets and *ActiveX Controls* will be better suited for intranets and extranets than for the *Internet.* Today, *ActiveX Controls* are probably primarily used on the *Internet* as the *Internet Explorer* counterpart to *Netscape's* plug-ins.

103 *Internet Explorer* utilises *ActiveX Scripting* to support *JavaScript* and *VBScript* (also referred to as *Visual Basic Scripting Edition),* the latter being a subset of *Visual Basic for Applications.*

1.2.2 DEFINING A "SOFTWARE COMPONENT"

There is no definition of "software component" commonly agreed upon, but the very word *component* at least seems to imply that composability is a critical property of components. In the literature, the term *component* is in fact used quite differently in different contexts. Firstly, it should be noted that in software engineering circles, "component" is usually understood in a very general sense, which has rather little in common with the more specific usage prevalent in the literature on the commercial software component technologies that primarily concern us here, i.e. *COM, ActiveX, .NET, JavaBeans,* and *CORBA.*[104] Thus, the "components" of the software engineering discourse would generally not qualify as components in the latter context, unless, of course, they happened to be implemented as, say, *COM* or *JavaBeans* components. In their book on distributed object technology, Orfali, Harkey, and Edwards define the properties a component must minimally have in their view:[105]

- It is a *marketable entity.*
- It is not a complete application, but it may be fine-grained (e.g. a C++ size object), medium-grained (e.g. a *GUI* widget), or coarse-grained (e.g. an applet).
- It can be used more or less *ad hoc* in unforeseen combinations with other components, at least if they belong to the same family, the members of which together are said to form a *suite.*
- It has a well-specified *interface,* separate from its implementation.
- It is an *interoperable object*[106], implying that it can be invoked as an object across address spaces, networks, languages, operating systems, and tools.
- It is an extended *bona fide* object supporting encapsulation, inheritance, and polymorphism. If the component supports inheritance, it is called a *white box component,* otherwise a *black box component.*[107]

Summing up, these authors make the following, rather broad definition:[108]

> *A component is a reusable, self-contained piece of software that is independent of any application.*

Many advocates of software component technology would not agree with these authors' claim that ordinary programme (i.e. *C++, Java, Smalltalk,* etc.) objects are to be classified as "components", although many authorities would certainly be inclined to treat distributed objects as such. Notably, *Microsoft's* interpretation of "components" as laid down in its *COM* and *COM+* technologies implied an at the time very controversial break with the object-oriented paradigm, theoretically underpinned by a critique of implementation inheritance. Thus, Kraig Brockschmidt in his classical book on *Microsoft's OLE* technology gives a somewhat dif-

[104] See, for example, [Same97b], [McCl97], and [BCK98]. See also below p. 38.

[105] [OHE96b] p. 34 et seq.

[106] The concept of *interoperable objects* seems to have been introduced by [Betz94], who also uses the term *component object* synonymously.

[107] The white-box vs. black-box analogy was first used by Johnson and Foote in [JF88] with reference to object-oriented frameworks. It was adapted to components by Jacobson et al. in [JCJÖ92] p. 296. Already McIlroy [McIl68] p. 90 insists that components should be regarded as *black boxes,* although he, of course, was not able to make the distinction between black-box and white-box components at that early time. Apparently, Orfali, Harkey, and Edwards do not regard black-box components as "true" components due to their failure to support inheritance.

[108] [OHE96b] p. 35.

ferent definition from the above, mirroring *Microsoft's* predilection for components as *binary* units in contrast to the *CORBA* approach, based on so called *IDL (interface definition language)* files:[109]

> *A software component is reusable pieces of code and data in binary form that can be plugged into other software with relatively little effort. Software components must adhere to an external binary standard, but their internal implementation is completely unconstrained.*

Soon, the *Microsoft* view received support from a group of independent researchers, who tried to set *component-oriented programming (COP)* off as a programming paradigm distinct from *object-oriented programming (OOP).*[110] The main forum of this research programme will be the *Workshop on Component-Oriented Programming (WCOP)* held annually from 1996 onwards at the *ECOOP (European Conference for Object-Oriented Programming)* conferences.[111] In the written summary of the first *WCOP* workshop, the following, often-quoted definition of a component surfaced:[112]

> *A component is a unit of composition with contractually specified interfaces and explicit context dependencies only. Components can be deployed independently and are subject to composition by third parties.*

None of these three suggested definitions is quite problem-free – the first one is so broad that it would cover almost any computer programme, the second one appears to – certainly a little polemically – exclude components based on a non-binary (e.g. *IDL)* approach, and the third one apparently forgets about "business objects" à la *Newi*[113]*,* which do not have any "contractually specified interfaces". Moreover, the statement that "components can be deployed independently" seems rather misleading – most types of components today are not capable of stand-alone execution, except for the very business objects excluded by the requirement for a contractually specified interface!

So what is a *software component* really? As many more attempts at a definition exist in addition to the three aforementioned ones,[114] there is no need for us to contribute one of our own making, nor do we wish to go further into the otiose splitting of hairs – as we saw, often only a pretext for promoting a certain favoured type of technology – usually involved in the attempts to arrive at the "correct" definition and terminological formula of what a *software component* is. On the contrary, we will take a pragmatic stance, viewing as a *software component* any entity that adheres to one of the more or less well-known *de facto* standards set down by the component technologies in the market overt. These include *Microsoft's COM, COM+, OLE, ActiveX, .NET,* and the now obsolete – or at least obsolescent – *VBX* controls*,* the *Object Management Group's CORBA and CORBA Component Model, Sun's JavaBeans* and *Enterprise JavaBeans,* and the defunct *OpenDoc* from *CI Labs* and possibly various minor players as well, such as *SSA's* also demised *Newi* system. As a matter fact, within this area one rarely speaks of components in a general sense – a component is a *COM* or *.NET* component, or a *CORBA* object, or a *VBX,* or a *Java Bean,* or an *OpenDoc part,* or a *Newi business object,* but not just a general

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[109] [Broc95] p. 8. Cf. also [Chap96b] p. 14 et seqq. For an explanation of the *IDL* concept, see p. 50 below.

[110] [Szyp98a], expected to appear in a second edition soon, will be the most important work, in which this programming style is advocated. Another work on software components written from a programming-oriented rather than a software engineering perspective and not primarily geared towards a specific technology, such as *COM, OpenDoc, JavaBeans,* or *CORBA,* is [Grif98]. Cf. also [HS00].

[111] See footnote 425 on p. 98.

[112] [SP96] p. 4. Cf. also [Szyp95] and [SP97a] p. 130.

[113] See [Sims94]. Cf. also below p. 142.

[114] Compilations of different definitions of the word "component" are found in [Same97b] p. 70 et seq. and [Szyp98a] p. 164 et seqq. Cf. also [BDHK+98], [CH01], and [CHJK02] p. 4 et seqq.

"component". Abstract "software components" only exist in the minds of the theorists and are of little interest to the practitioner, except as a generalisation during software design.[115]

As it appears, *software reuse* is the very purpose of *software components,* but components, as supported by the component infrastructures provided by *COM, .NET,* and *JavaBeans*, differ from traditional reuse mechanisms, such as function and class libraries or object-oriented frameworks, mainly by a larger degree of independence and self-containedness. It has long since been widely acknowledged that the road to *reuse* goes via *encapsulation,* and *components* indeed are supposed to exhibit a high degree of *encapsulation,* which, most importantly, should be combined with a *self-containedness* that sets them apart from other encapsulated entities like objects, modules or packages. Components may come in many shapes and may span a large range of granularity, but they should exhibit some degree of *plug-and-play interoperability,* implying that the user of a component should not be burdened with an excessive amount of work to put the component to use. As we will see, the various component technologies differ in a number of significant ways, such as their degree of commitment to the object-oriented paradigm, their support for a binary, IDL-based, or byte-code-based "virtual machine" standard, their intended target of deployment *(GUI* widgets, business objects, transaction processing, Internet…), the granularity-level they primarily target, etc.

1.2.3 TYPES OF COMPONENTS

Some common types of components can be distinguished. Actual components often combine support for more than one of the types below. For instance, a typical *ActiveX control* is both a visual programme component and a potential *Internet client-side* component. These are types of components that usually execute on a client machine, typically a personal computer:

- *programme component* – a component, which must be part of an application programme and has a well-defined call interface, but not necessarily a user interface

- *visual programme component* – a programme component, which must be part of an application programme and, in addition, has a user interface; most *VBX, OCX* and *ActiveX controls, JavaBeans,* and *OpenDoc parts* belong here

- *Internet client-side component* – a component capable of execution inside an *Internet* browser, probably as part of a web page; *Java applets, Java Beans, ActiveX controls, Dynamic HTML (DHTML)* or *XML scriptlets,* and *HTML Components (HTCs)* belong to this category

- *compound document component* – a document that can be embedded or linked into another document (e.g. an *Excel* spreadsheet inserted in a *Word* document)

- *document component* – a document that exposes an automation (i.e. macro programming) interface

- *automated monolith* or *automation server* – a monolithic application with an automation interface, which makes it possible for a script to control the application through a number of *automation objects,* which it exposes to users; *Microsoft Word* and *Excel* are examples of such very large-grained components, which expose such *automation objects* or *ActiveX objects* as *Application* and *Document*

- *executable object* (sometimes also referred to as a *business object)* – a component that is capable of executing on its own and co-operating with other components through some kind of messaging or automation mechanism

There are also various server-side components, i.e. components that are supposed to execute on a server rather than on a client computer:

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[115] This is reflected in the literature, which mostly is geared towards one or other of the commercial component technologies. Only a few books, including [OHE96b] and [Szyp98a], have attempted to span the whole area of *software components*.

- *distributed object* – a kind of object providing services over a network or, as some would prefer to put it, an "object bus"

- *transaction monitor component* – a component, which executes inside a transaction monitor, such as a *MTS/COM+* component designed for execution in *Microsoft Transaction Server (MTS),* an *Enterprise Java Bean (EJB)* intended for some *EJB*-compatible transaction processing monitor, or a *CORBA Component* supposed to execute in a transaction monitor that supports the *CORBA Component Model*

- *Internet server-side component* – a component, which executes inside a web server, such as *Microsoft's Internet Information Server (IIS)*

After this short introduction to the "software component" concept and the different uses that are made of software componentry in present-day technology, the history of the component idea in software engineering and software development will now be outlined.

1.3 A SHORT HISTORY OF SOFTWARE COMPONENTRY

The visions of two eminent computer scientists, Douglas McIlroy and Brad Cox, provide the foundation and backdrop of today's software component business. These two visions, each aiming at the expunction of the software crisis hydra, each being based on the software component idea, each representing a distinct era in the understanding of this idea, both proved reasonably successful, although neither has been able to bring the battle against the software crisis to a successful end. One is now deemed to belong to the past, if not in practice, so at least in spirit, whereas the other is still the anthem *du jour*. Fundamental to both is the belief that software construction would gain immensely by taking its cue from hardware construction.

In the history of software components, McIlroy and Cox stand out mainly by virtue of the significance of their visions and the programmes they formulated, although their technical exploits and astuteness indeed challenge attention as well. It is the belief of the present author that important insights might be gained by revisiting their ideas and that the character of these insights will be twofold. On the one hand, we may advance and deepen our understanding of the history of software construction by ferreting out patterns and connections in the web of ideas of which large portions were woven by these two component champions – as well as by others using the yarn once spun by them. On the other hand, we may profit directly in our current software component endeavours from these very same ideas, the true potential of which still remains to be fathomed, as well as from the experiences made when trying to put these ideas to use in the past. Here we will espouse the view that components have a Janus face, and that one facet is about the technological *shape*[116] of components, the other about economy, business contexts, and marketing aspects.[117] This view is much in the spirit of both McIlroy and Cox, and we will consider both of the two facets in our account of their ideas.

1.3.1 DOUGLAS MCILROY – MASS PRODUCED SOFTWARE COMPONENTS

The catch-phrase *software component* seems to have been coined by Douglas McIlroy in the invited address entitled *Mass Produced Software Components* he delivered at the *NATO* conference on software engineering in Garmisch in October 1968.[118] Although the significance of this coinage was not appreciated at the time, Mc-Ilroy is now regularly paid obeisance to as the father of software components and software reuse by authors who write on either of these subjects. Superficially, it may even appear that the *software component* idea fell into immediate desuetude, until it was resuscitated by the wave of interest in reuse in the early 80s. In actuality, important parts of McIlroy's programme were, however, realised inside some of the more spectacular software endeavours of the 70s.

1.3.1.1 The Plight of Software and the Paragon of Hardware

In his landmark talk, McIlroy inaugurates the habit of contrasting hardware and software construction practices by this mordant proem:

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116 *Shape* is here understood in approximately the same sense as in [Sims94], where it denotes the general structure of software end-products.

117 Encouragingly, this two-faced approach is also adopted in [Szyp98a], Szyperski's important book on component software.

118 [McIl68]. The proceedings of this conference [NR69] were reprinted in 1976 as [NRB76] together with the proceedings of the 1969 sequel conference [BR70]. The different printings are repeatedly mixed up, and the existence of the reprint has caused some odd misunderstandings (e.g. in [Meye97] p. 99). [Maho90] and [Rand79] give some background information about the *NATO* conference. The exalted sense of importance perceived by the participants is reflected in afterthoughts such as Randell's ([Rand79] p. 6): "It is difficult if not impossible to convey to anyone that was not there the sense of excitement and even missionary zeal that all this activity engendered." McIlroy himself looks at the event from a more ironical angle in [McIl72], a follow-up to [McIl68]: "The NATO Conference was a heady group therapy session, full of breastbeating about the software crisis and the general malaise of our trade and the way we practice it."

Isolated fits of component thinking certainly occurred before the *NATO* conference. For instance, [TK89] p. 466 describes the anno 1957 *Minuteman* missile simulation system, which was built from separately developed, encapsulated software "components", with their own data and methods and capable of mutual information exchange! Oliver Selfridges's notion of *demons,* presented in [Self58], also comes close to components and was motivated by the important observation that "it is easier to modify an assembly of quasi-independent modules than a machine all of whose parts interact immediately and in a complex way". Cf. also Licklider's proposal in [Lick60] of "real-time concatenation of preprogrammed segments and closed subroutines".

> *We undoubtedly produce software by backward techniques. We undoubtedly get the short end of the stick in confrontations with hardware people because they are the industrialists and we are the crofters. Software production today appears in the scale of industrialization somewhere below the more backward construction industries.*

After having worked out the details of his analogy, McIlroy goes on to scourge the monolithic ethos of software construction:

> *The pinnacle of software is systems - systems to the exclusion of almost all other considerations. Components, dignified as a hardware field, is unknown as a legitimate branch of software.*

As an antidote to the cumbersome state of the software industry, he suggests *software components* moulded on the components from which hardware is built:

> *My thesis is that the software industry is weakly founded, and that one aspect of this is the absence of a software components subindustry.*

This is an idea of paramount importance, nay, the very gist of software component technology. The contrasting of hardware success and software failings and the notion that software construction should embrace the encapsulation principles that have proved successful in the hardware industry – and indeed in many other branches of engineering and industry – are nowadays well-established keynote motives of component literature.[119]

1.3.1.2 Mass Produced Software Components

By the epithet *mass produced,* McIlroy brings out the importance of industrial techniques for software production – mass replication of software is, of course, trivial, as he also points out. In particular, he holds that components should come in "parameterized families" – an analogue of the families of hardware components – and that "automated techniques" should be used for the "mass production" of a wealth of variants of components.[120] He suggests that specialised *components factories* should be established in order to make industrial

[119] A miscellany of passages and articles repeating this theme will include [Edwa75], [WB78] p. 31, [BGMW+80] p. 172, [WG82], [RS83] p. 130, [Booc87] p. 5 et seqq., [WOZ91] p. 2 et seq., [CN91] p. 26 et seq., [JCJÖ92] p. 27 and p. 291, [Broc95] p. 95, [Chap96b] p. 14 et seq., [OHE96b] p. 32 et seq., [Berg97], and [Szyp97].

[120] *Parameterization* here partly pertains to language and system portability issues, partly to various trade-offs. The parameters of the components belonging to a *parameterized family* may represent such aspects as precision (including character and pointer size), robustness, time-space trade-offs, choice of algorithms and data structures, interface styles (including error-reporting styles), and storage access methods. Only a few of these parameters will need to be represented by distinct versions of the components, whereas others will simply become arguments to the component routines. McIlroy brings up "the lowly sine routine" as an example and estimates the number of variants needed at around 300 or even more! Hand coding is patently inappropriate here, and "automated techniques" and "various editing and binding techniques" are suggested to alleviate the chore of writing such a wealth of routines. In short, McIlroy suggests that component variants should be created at "sale time" from a "few models, highly parameterized" through code generation and macro techniques. In the late 70s, Parnas advocated the construction of *program families,* a somewhat related idea; see [Parn76] and [Parn79]. McIlroy later worked with Stroustrup on *C++* (see [Stro96a] p. 715) and played a substantial part in devising its overloading (id. op. p. 723) and template mechanisms (id. op. p. 743). These features may be used to create parameterised families of components of a kind not too far from what McIlroy had in mind in 1968. Although not part of present-day commercial component technologies like *COM* and *JavaBeans*, type parameterisation has repeatedly been claimed a key ingredient of the component vision, as witnessed by [Ichb83], [Gogu86], and [Jaza95]. Cf. also [Gogu83] and [Gogu89].

planning, testing, and distribution techniques feasible also within the backward craft of software development.[121]

In his discussion of software components, McIlroy introduces themes of thought and terminology, which have since recurred ever and anon in the discourse on computer software and programming. For example, he parallels the *interchangeable parts* of hardware with the software term *modularity,* he mentions taking components *off the shelf,* he thinks of components in terms of *building blocks,* and he argues that they should be regarded as *black boxes.* He takes exception to the mentality of asking what to *build* rather than what to *use,* although his paper is still unencumbered by the term *reuse.*[122] Although he does not delve into great technical detail, he hints at notions and techniques that were to prove important in the future such as code generation, language independence, and even the dichotomy between interface and implementation.

In some respects, however, McIlroy's understanding of components is fundamentally different from that of today. Firstly, he conceives of components as stored and traded in the form of source code, not as binaries, and he states that they may have to undergo some "transliteration" before compilation and use, although this should be "essentially direct".[123] Secondly, he defines components as "routines", which is to say that the idea of encapsulation of state as well as behaviour is not present, let alone the notion of extensibility mechanisms such as inheritance or aggregation.[124]

1.3.1.3 Marketplace Aspects

McIlroy, having a keen eye also for the market aspects of components, pointed out the troubles of financing: "Large financing can usually only be obtained for large products." This is an important observation; the difficulties in creating rational payment mechanisms for small, easily copied chunks of software, rather than technical shortcomings or problems, remain the chief impediment to components, although this is not always duly recognised. He suggests governmental programmes to counter these troubles, at least initially.

The need for standards – of programming languages, interfaces, word sizes, character sets – is also considered, but McIlroy warns against rash standardisation efforts, before the "models" are in place.[125] The path recommended is rather one of industrial convergence.

McIlroy enumerates the component application areas he thinks are "promising … to begin with":

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[121] [Beme68] (cf. also [NRB76] p. 60 et seqq.) also discusses a proposal for a *software factory,* and [Cusu89] p. 24 reports that Hitachi in fact established one in 1969. Bemer's and McIlroy's ideas were, however, independent developments.

[122] Although McIlroy is commonly acclaimed the father of *reuse*, [Beme68] also touched upon this idea and actually employed the term *re-usage*. McIlroy's treatment of the subject is, however, much more comprehensive. Interestingly, McIlroy's example of where *use* is preferable to *build* is the "table mechanism" of compilers – symbol tables were to become a stock example of reuse pleas (cf. [Cox86] p. 27, [Stan83] p. 495, [CA83] p. 520 et seqq., [CCGH+71] p. 2, and [CW72] p. 3)

[123] This view of components is not shared by present-day software component technologies, but is still alive in reuse literature. [Coul98], for example, discusses components for specification, design, and *code*.

[124] It is odd that none of the more prominent adherents of structured programming, modularisation, and object-orientation embraced the component idea. Only a few key personages of these camps, such as Dijkstra and Reenskaug, were actually present at the *NATO* meeting where McIlroy delivered his landmark talk. The *SIMULA* inventors Nygaard, Myhrhaug, and Dahl contributed a paper to the conference, but did not take part in the meeting, according to the list of participants ([NRB76] p. 132 et seq.). Although McIlroy himself was aware of the *class* concept of *SIMULA* already in 1968, he did not then associate it to his own ideas about software components. From the intriguing passages in [NRB76] p. 62 et seqq. and p. 95 about the *plex* and *feature-feature* concepts, it appears that, at the *NATO* conference, Douglas Ross was not too far from connecting McIlroy's components with something having the air of an object-oriented approach and that Alan Perlis in fact brought up *SIMULA*-style modelling during the debate that followed upon Ross' comments. Cf. also [McIl72] p. 246 et seqq.

[Wegn84] p. 12 states that "research on data abstraction, object-oriented programming, and modularity in the 1970's was motivated by the desire to develop a viable software components technology", but besides a not very influential paper by Edwards [Edwa75] I have not been able to find any printed evidence in support of this statement, at least if it is taken literally. The possible influence of McIlroy's ideas upon the design of *Ada* is touched upon below on p. 38. It seems that when McIlroy's paper and the component idea were rediscovered in the beginning of the 80s, some people felt that *components* were basically what they had been doing all the time, although they had called them objects, modules, packages, or something else.

[125] Thirty years later, warnings against rushing into standards are still issued, e.g. in [Szyp98a] p. 263.

- numerical approximations
- I/O conversions
- 2D/3D geometry
- text processing
- storage management

Interestingly, he suggests distribution through "Sears-Roebuck" style catalogues of components as well as "by communication link".[126] The idea about an *Internet*-based ***component bazaar*** is not as new under the sun as one may be tempted to believe!

1.3.2 COMPONENTS DURING THE 70S

Douglas McIlroy did not invent reuse, nor subroutines or subroutine libraries as vehicles of reuse.[127] He was, however, the first one to formulate subroutine-based reuse programmatically, and, most importantly, he established the habit to couch reuse pleas in terms of software components.

An attempt to track out the dissemination of the component idea during the 70s will be made below. The visible repercussions of McIlroy's paper during the 70s are scant[128], but one important influence that we will come back to soon was on Neighbors' *Draco.*

1.3.2.1 Software Components at Bell Laboratories

During the years 1965-86, when McIlroy headed the *Computing Techniques Research Department* at *Bell Laboratories,* the *UNIX* operating system and the *C* and *C++* languages saw daylight at this very department and McIlroy was instrumental in the gestation and creation of them all.[129] The standard libraries of *C* and the system libraries of *UNIX* indeed implement subroutine-based components of the kind contemplated in McIlroy's 1968 paper, and his ideas about automatic generation of variants of these libraries, optimised for different machine architectures, were at least partially made viable by the *C* macro pre-processor.[130] Except for the geometry routines, the component categories "promising … to begin with" correspond closely to the *C*

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[126] At about this time, the *Information Processing Techniques Office (IPTO),* being part of the *Advanced Research Projects Agency (ARPA)* of the U.S. *Department of Defense,* was in the process of organising the first phase of the work on the *ARPANET.* 1968 was also the year of publication of [Lick68], Licklider's famous and very influential article *The Computer as a Communication Device,* in which many aspects of today's *Internet* and *WWW* technologies were forecasted. See also [Pres96] and [HL96] p. 24 et seqq.

[127] Indeed, McIlroy criticises one early reuse effort, the *CACM* collected algorithms, for various deficiencies. It could be claimed that the history of reuse started with the invention of the subroutine by Goldstine and von Neumann (see [GN48]) or at least with its implementation in the *EDSAC* by Wilkes, Wheeler, and Gill (see [WWG51]). The support for separately compiled subroutines in *FORTRAN II* (see [Back78]) made subroutine-based reuse easy already back in the 50s. At this time, user groups like *SHARE* (founded in 1955) distributed catalogues of useful software routines, which according to [Glas81] were widely used. In the late 60s, some comprehensive subroutine packages and libraries were built, e.g. in Douglas Ross' *AED (Automated Engineering Design)* project at *MIT.* McIlroy recounts (in [McIl98]) that back in 1962 he himself built a package of text-processing primitives that became the basis for an implementation of *SNOBOL.*

[128] Among the 24 "classics" of software engineering included in [Your79], none refers to McIlroy's paper, and only very occasional references are found in other literature from this time. For example, [Baue73b] p. 536 dismisses McIlroy's proposal of "'software components' which allows software to be built mosaic-like from a multitude of mutually harmonized small pieces" thus: "Such an ambitious goal is not likely to be attacked successfully in the near future." Cf. also [Helm73] p. 514, where McIlroy's critique of the *CACM* algorithms is cited. [McIl98] reports some additional influences on the *National Software Works* project. When the interest in reuse issues awoke in the early 80s, McIlroy's paper was rediscovered. At the 1983 *ITT Workshop on Reusability in Programming,* the paper was revisited in [HM83] p. 254 et seqq. and referred to also in [Stan83] and [Free83]. Since then, it has been very frequently cited.

[129] See [McIl96].

[130] McIlroy's macro processor for implementing *ALTRAN* in *FORTRAN* was in his own words (in [McIl98]) "probably the main ancestor of the C preprocessor", and he adds "the C preprocessor did flow from the same outlook that my components paper did, but it was not a deliberate step towards a components goal". Cf. also [McIl69], [McIl72] p. 249, [Wegn84] p. 13, and [Kern83].

library functions.[131] Additionally, McIlroy was the inventor of the pipes and filters mechanisms of *UNIX,* at least *prima facie* another striking application of the component idea.[132]

1.3.2.2 Software Components and Automatic Programming

During the 70s and 80s, there was a strong interest in *automatic programming* in academic research. The aim of *automatic programming* is the more or less automatic generation of an executable programme from a specification expressed in a *very high-level language (VHLL),* or perhaps even in natural language, through various "refinements", "transformations" or "optimisations", usually under some form of interactive guidance from a user/programmer. The point is that the automatic programming system may automate various implementation choices such as the selection of algorithms – with or without human assistance.[133]

One *automatic programming* research effort that was inspired by McIlroy's component vision was Neighbors' *Draco*[134], a component-based system for the construction of domain-specific languages and the generation of executables from high-level specifications written in such languages.[135] Much in the spirit of McIlroy, Neighbors contrasts the "the parts-and-assemblies approach" of *Draco* with "the craftsman approach" routinely adopted in software development.[136]

The *components* of *Draco* are functions just like those of McIlroy's. These *Draco* components provide the implementation of the *objects* and *operations* of a certain problem domain[137], and there is exactly one component for each object or operation of a domain. Every component may contain several alternative implementations

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[131] Cf. [KR88] p. 241 et seqq.

[132] The story related in [BP84] p. 475 that pipes and filters were devised not as a reuse mechanism, but in response to the severe address space limitations in the early versions of *UNIX* is denied by McIlroy himself. In [McIl98], he reports that he came up with the pipes and filters idea before the *UNIX* days and actually tried, although unsuccessfully, to solicit its implementation in a mainframe operating system. His intention was "to enable functional composition of existing components", whereas the inspiration for this ingenious contrivance was provided by stream processing and co-routines.

[133] Most research forays into automatic programming, such as those of Balzer's group at *USC/ISI* (see [Balz83], [Balz85], and [Feat83]) or the Harvard group headed by Cheatham (see [Chea83]), have not been based upon the component idea. [RW92] contains a survey of the area of automatic programming, including a discussion of some commercial products (on p. 44 et seqq.) Cf. also [HK85] and [BCK98] p. 427.

[RW83], [RW89], and [RW92] present an alternative approach to automatic programming based on what they originally used to call *components,* but later renamed *clichés,* and a formalism for representing these called the *Plan Calculus.* In their terminology, a *cliché* or *component* may represent any commonality between programmes. The examples of such components given in their papers include such diverse items as "matrix add", "stack", "filter positive", "master file system", "deadlock free", "move invariant", "successive approximation", "interrupt-driven architecture", or "information system". In addition to the plans of the *Plan Calculus,* English text, subroutines, macros, programme schemas (a kind of templates with holes to be filled in), flowcharts, logical formalisms, data abstractions, and programme transformations are considered candidate formalisations of components.

A major research effort on component-based "GenVoca generators" is currently carried out by the *Software Systems Generator Research Group* at the *University of Texas* in Austin (see [BO92], [SB93], [BSTD+94], [Bato97], and [SB98]). *GenVoca generators* use parameterised "refinements" of domain abstractions as building blocks, the implementations of which are referred to as *components.* In this context, the term *component* signifies a "subsystem", which is defined as a suite of variables, functions, and classes. Subsystems are considerably more large-grained than the function components of *Draco;* as for the need for larger building blocks than functions, cf. [Neig89] p. 315 et seq. *GenVoca* components may be composed *statically* at application generation time or *dynamically* at application run-time. Furthermore, these components may be *compositional* or *transformational.* Compositional components are executed at application run-time and may be implemented statically as templates or dynamically as object libraries, whereas transformational components generate code that, in turn, will be executed at application run-time. [OL93] presents another recent example of research on *component*-based generative techniques. Of late, there seems to have been a minor renaissance for this kind of approach, as witnessed by the symposia/conferences on *Generative and Component-Based Software Engineering (GCSE),* the proceedings of which have been published as [CE00], [BJ01], and [Bosc01].

[134] *Draco* is described in detail in Neighbors' doctoral dissertation [Neig80]. Shorter descriptions are available in [Neig83], [Neig89], [Free84], and [Free87b]. Cf. also [ABFP86] and [HM83] p. 255 et seq., where some concerns about the *Draco* approach are considered as well. A most important contribution of Neighbors' was the introduction of *domain analysis* to serve as the foundation of domain-specific languages.

[135] According to Neighbors (see [Neig80] p. 140), the use of components in *Draco* was also inspired by N. P. Edwards [ET74] and R. C. Waters [Wate76]. Cf. also [Neig80] p. 5 et seqq., p. 11 et seqq., p. 67 et seqq., p. 132 et seqq.

[136] [Neig80] p. 5 et seqq.

[137] Objects are not understood in an object-oriented sense here.

called *refinements,* which may be regarded as macro bodies for the represented object or operation.[138] The *Draco* components are managed through a *module interconnection language,* which also ensures the consistency of the system under construction.[139] The *Draco* components provide the semantics for a domain-specific language, the syntax of which is defined during domain analysis. *Draco* generates a parser for this language from a specification in a BNF style notation.[140] The language constructs may then be used to assemble multiple systems within a domain from predefined parts (i.e. components) instead of building them from scratch by "using craftsmen". The translation, or refinement, of a specification written in a domain language into executable code is done interactively through "transformations". The approach described may pay off when many similar systems will be built. It implies *reuse* not only of *code,* but also of *analysis* and *design,* which is claimed to be "the key to reusable software".[141]

1.3.2.3 Software Components and Software Engineering

A *patch panel* model for anonymous interconnection of *modules* through *ports* was devised by a team of researchers at Carnegie-Mellon University in the early 70s.[142] Their approach was directly inspired by developments in hardware construction and was justified by a wish to reuse large-grained software components. In the implementation made of the patch panel model, the SL230 *software laboratory,* the *modules* were realised as asynchronous processes, although other implementations such as subroutines or co-routines were considered feasible as well. The *patch panel*, interestingly equated with a "telephone switchboard", was implemented by a set of mailboxes and the *ports* as names local to its owning module. The ports were connected to the mailboxes by *cabling* – thereby making it easy to substitute a module for another by just doing some re-cabling.

In 1974, Edwards and Tellier of *IBM* presented some ideas about a parts-and-assembly approach to software construction, apparently inspired by the practices of other engineering disciplines in general and hardware construction in particular.[143] Somewhat later, Edwards advocated "controlled modularity" as a way to bolster software construction with "re-useable parts".[144]

In the late 70s, the analogy between hardware and software components was revived in the *Oregon report* on future software engineering and in a number of articles and papers related to this report.[145] Just as the hardware engineer works with prefabricated circuits, the software engineer of the future should, it is contended here, work with an inventory of quality-tested, standard components, thereby becoming able to pursue *programming in the large* rather than *in the small.* These components may be of very different granularity, and initially it may be difficult to find and agree upon the best sizes and shapes for them. In most cases, however, the authors of the articles in the *Oregon report* appear to equate "components" with *modules.* Consequently, module interfaces is considered an important research area, and families of "plug-compatible" modules with

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[138] For example, [Neig80] p. 69 et seqq. discusses an exponentiation component containing two refinements: a binary shift implementation and a Taylor expansion variant. The language used to define the refinements may be any domain language known to *Draco,* so the implementations of components may cross domain boundaries. Cf. also [Neig89] p. 305 et seq.

[139] [PN86] provides a survey of module interconnection languages. The first *MIL* was devised by DeRemer and Kron (see [DK76]) in order to facilitate the activity of "programming-in-the-large", i.e. the knitting together of programme modules into systems. One interesting feature of these languages is that they, in addition to declarations of the interface *provided* by a module, also support constructs, by means of which the interfaces *required* by a module can be specified. Declarations of required interfaces form the basis of "plug and socket" architectures such as that of the *Rapide* language described in [LV95] and [LVM95].

[140] Additionally, a "domain language prettyprinter" and "source-to-source transformations" must be defined before the domain language may be taken advantage of.

[141] [Neig80] p. 13.

[142] See [CCGH+71] p. 3 et seqq. and [CW72] p. 4 et seqq. The *patch panel* model may be understood as a predecessor of later *plug and socket* architectures as well as of *module interconnection languages*.

[143] [ET74]. There does not seem to have been any direct influence from McIlroy's two component papers on their work, nor on that of the Carnegie-Mellon group. [BL80] p. 128 relates that somewhat later *IBM* made a product announcement for what was called "selectable software units". Cf. also footnote 162 on p. 36 below.

[144] [Edwa75]

[145] [WB78] and [BGMW+80] summarise the ideas aired at this workshop. Cf. also [Bela79], [BM80] p. 128 et seqq., and [WG82]. At least some of the originators of this report were aware of McIlroy's ideas, as witnessed by [BM80] loc. cit.

identical interfaces, but different implementations are suggested.[146] This is undoubtedly an important step towards the modern concept of components and away from McIlroy's original view of components as routines.[147]

1.3.2.4 Related Developments

Some other developments of the 70s tend to confirm the validity of McIlroy's ideas, but lack directly observable ties with them.

Firstly, a market for subroutine libraries evolved, and it was further fostered by the arrival of the microcomputers.[148] The size of this market has, however, remained comparatively small, although the function library, whether provided in the form of operating system *APIs,* as compiler appendage, or bought from third parties, will still be an important instrument of reuse today.

Secondly, the first software factory was opened in Japan by Hitachi already in 1969, and several others were established in Japan during the late 70s.[149] In the Western hemisphere, the software factory idea has been much more loath to take root, except for a few ephemeral attempts.[150]

Thirdly, an interest in *software reuse* slowly began to sprout in industry as well as academe.[151] The reuse strategy adopted at *Raytheon's Missile Systems Division* during the late 70s reportedly occasioned reuse rates of 40-60% and involved the construction of a library of 1500 *COBOL* code modules.[152] The academic preoccupation with reuse was still inconspicuous and largely isolated to some pioneering activities at the *University of California* in Irvine, where Neighbors worked on the *Draco* system, and Freeman, Standish, and others made various contributions.[153]

Additionally, a number of other important endeavours of the 70s would turn out to have bearing on the component idea. These include work done on structured programming, information hiding, coupling and cohesion, modularisation, abstract data types, and object-orientation and, of course, the development of languages such as *SIMULA, Smalltalk,* and *Ada.*

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[146] [WB78] p. 37

[147] Another example of the percolation of the software part idea during the late 70s can be found in [Rice80] p. 706 et seq.

[148] The early examples surveyed by [Free83], [HM83], [Stan83], [RS83], and [Jone83] include linear programming packages, statistics and numerical analysis libraries such as the one from *IMSL, Raytheon's ReadyCode* library for *COBOL* business applications, and various *BASIC* microcomputer modules. Cf. also [Rice80] p. 694 et seqq.

[149] [Cusu91] is the standard work on Japanese software factories. [Cusu89] gives an excellent summary of the history of the software factory in Japan and elsewhere. [MSNT+81] and [Mats87] describe Toshiba's software factory. More information about the Japanese developments can be found in [Kim83] and [TM84]. Cf. also [JGJ97] p. 6.

[150] [McIl72] mentions that Douglas Ross' group at the time advertised itself as a "software factory". In 1974, *System Development Co. (SDC)* trademarked the term *software factory,* and during 1972-78 *SDC* developed a software factory process and performed successful full-scale experiments with it. In spite of impressive results, the factory was finally closed down because of the unwillingness of *SDC* project managers to commission work to it. See [BC75] and [Cusu89] p. 25 et seq.

[151] As mentioned in footnote 127 on p. 31, some reuse efforts such as the *CACM* collected algorithms and the *SHARE* programme, which undertook to encourage reuse of donated *IBM* mainframe subroutines, were much older than that. None of these was, however, particularly successful. Cf. [RS83] p. 129.

[152] See [LP79] and [LG83]. [Emer79] relates the results of an attempt at *Control Data Corporation* to identify *small-scale components,* i.e. small functions or macros for frequent operations on arrays, lists, strings, and the like.

[153] [Free80]. There may have been some influence from this group on the early development of the *Ada* programming language. See [Whit96] p. 216.

The 1983 *ITT Workshop on Reusability in Programming* ushered in a period of intense interest in reusability[154], spurred by inter alia the long-running and well-funded *U.S. Department of Defense STARS (Software Technology for Adaptable, Reliable Systems)* effort.[155] Whereas subroutines had been the most common reuse vehicle of the 70s, during the 80s the interest shifted towards the novel mechanisms of *Ada* and the emerging object-oriented programming languages, i.e. packages/genericity and objects/inheritance, respectively. The *Ada* and the object-oriented camps each came up with different re-interpretations of the *software component* idea. Here we will be primarily concerned with the object-oriented variant, which was given its first, very pithy formulation by Brad Cox – a formulation that will be subject to further study below.

1.3.3.1 Software-ICs

During the first years of the 80s, Brad Cox was working on the *ITT Programming Environment* project, the aims of which were to increase programmer productivity and encourage extensive reuse.[156] Cox designed and built the *Object Oriented Pre-Compiler (OOPC),* "a language and a run-time library for producing C programmes that operate by the run-time conventions of Smalltalk 80".[157] In 1982, Cox and Tom Love founded *Productivity Products International (PPI),* later renamed *Stepstone,* in order to exploit object technology for the creation of a market of reusable object-oriented components, aptly dubbed *Software-ICs.* To achieve this goal, Cox developed the *Objective-C* language and compiler, using *OOPC* as a starting-point. In 1986, Cox' book *Object-Oriented Programming – An Evolutionary Approach* was published; as one of the first accessible accounts of object-orientation – and written in a lambent, captivating style at that – it became very influential.[158]

Much in the same vein as McIlroy, Cox motivates his approach by the software crisis.[159] He detects the roots of the crisis in the lack of changeability and malleability, which he in turn imputes to the tactics of "Maginot line defense" typical of monolithic software construction. He contrasts this inflexible "line defense" to the "Swiss defense" strategy of compartmentalisation "into armor-plated objects" used in *Smalltalk* programming.[160]

Cox – like McIlroy – believes that the medication needed to jugulate the software malady may be fetched from the hardware fabrication area:[161]

> *The silicon chip is the unit of hardware reusability that has most conspicuously contributed to the hardware productivity boom. Might the Software-IC concept do the same for software?*

[154] [ITT83] contains the proceedings of this conference. More or less revised versions of some of the papers presented were reprinted in *IEEE Transactions of Software Engineering,* Vol. SE-10, No. 5, [Free87a], and [BP89]. The rise of interest in software reuse in the early 80s is also reflected in [Rauc83]. [Sepp87] contains a good survey of the *reuse* articles and papers available in 1987.

[155] Cf. [DRR83].

[156] Cox at this time worked within the *Advanced Programming Group* of *ITT's Advanced Technology Center (ATC).* The *ITT* reuse workshop was organised by Capers Jones of *ATC,* the interest in reuse issues within *ITT* being strong. According to [Cox98], McIlroy's component paper was also very much "in the air" at this time.

[157] [Cox83]

[158] [Cox86]. At this time, there were only few books available on object-orientation (e.g. [BDMN73], [GR83], and [Kras83a]), and they were all geared specifically towards *SIMULA* or *Smalltalk* programming. This very same year, Bjarne Stroustrup published his best-seller [Stro86], *The C++ Programming Language.*

[159] See [Cox86] p. 4.

[160] [Cox86] p. 3 et seqq. In his later writings, he depicts the state of software construction more drastically. For example, in [Cox96] p. 66 he trenchantly states: "Software is not yet in the twentieth century, but in the Dark Ages. It is still dominated by the Platonic ideal, Ptolemaic cosmologies, alchemists in search of philosophers' stones and techno-centric silver bullets."

[161] [Cox86] p. 26.

Cox parallels the introduction of *Software-ICs* with Eli Whitney's introduction of interchangeable standard parts into musket building in 1798 as a means of bringing about division of work – an innovation that made possible the transition from manual to industrial production known as the industrial revolution.[162] He also revives McIlroy's idea about software component factories, but renames them *Software-IC foundries*. In the first widely available account of *Software-ICs*, in a *BYTE* article, Cox and Lamar Ledbetter offer an interesting definition of *Software-ICs*. They associate the new concept with subroutine libraries and *UNIX* filters, i.e. McIlroy's *software components*:[163]

> *A Software-IC is a reusable software component. It is a software packaging concept that combines aspects of subroutine libraries and UNIX filter programs. A Software-IC is a standard binary file produced by compiling a C program generated by Objective-C.*

By defining *Software-ICs* as objects packaged as binaries, Cox unites the message/object programming style with the component idea.[164] The user of a *Software-IC* only sees its *interface* and does not need to care about its implementation – these are the well-known principles of encapsulation and information hiding, advocated by Parnas and others already during the heyday of structured programming. It does, however, imply a clear-cut break with McIlroy's conception of components as source code routines.

Objective-C is a language in the *Smalltalk* tradition, supporting dynamic binding, dynamic typing, and dynamic linking fully, and Cox makes dynamic binding and loose coupling a cornerstone and a *sine qua non* of *Software-ICs*. In fact, this dynamism makes *Objective-C* less susceptible to the syntactic fragility pitfalls that haunt *C++* programming and latter-day component infrastructures, such as *COM* and *SOM,* have gone to great lengths to overcome.[165]

1.3.3.2 Creating a Market – Superdistribution

For various reasons, *Stepstone's* hopes about a market for *Software-ICs* foundered. Firstly, *Software-ICs* were tightly coupled to *Stepstone's Objective-C* language, which was soon to be overshadowed by *C++* – *Stepstone,* of course, simply lacked the clout to compete with *Bell Laboratories*. Secondly, no standardised interaction protocols existed for *Software-ICs,* let alone any standard interfaces, and hence *Software-ICs* from different providers became liable to various *architectural mismatch* problems.[166] Thirdly and most importantly, it turned out to be difficult for software developers to earn a living on the construction of small pieces of software – the problems inherent in marketing and selling software building blocks had not been addressed.[167]

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[162] [Cox86] p. 1 et seq. Cox comes back to this theme in many of his later writings. In [Cox96] p. 115 et seqq., he gives a detailed account of Whitney's invention, the credit of which really turns out to fall upon a French gunsmith, Honoré Blanc, rather than upon Whitney himself. In a number of influential articles ([Cox90a], [Cox92], and [Cox95]), Cox couches his ideas about the software industrial revolution as a remonstrance against Brooks' even more influential *No Silver Bullet* article [Broo87] and its main thesis that complexity is an essential property of software. Cf. also [Ochs92] and Brooks' reply in [Broo95] p. 210. [ET74] p. 618 probably provides the first argument for the application of Whitney's parts-and-assemblies approach to software and actually influenced Neighbors (see [Neig80] p. 5). In [SM97], Whitney's achievement is also adduced, but in support for Shlaer's and Mellor's "recursive design" method. Cf. also [Part96] p. 19 et seqq.

[163] [LC85]. A more elaborate treatment of the same topic can be found in [Cox86] p. 17 et seqq.

[164] Interestingly, [Schm86b] p. 182 reports that the term *software-IC* originally was intended to signify "a machine-independent class", but later came to denote any "well-designed class".

[165] As pointed out by [Wegn84] p. 20, *Ada* (and *Pascal)* lacks support for dynamic binding, linking, and loading and, thus, only supports statically bound components.

[166] Cf. [GAO95]. Cf. also [Cox90a] p. 216

[167] [Cox96] p. 41 et seqq.

Out of this failure, however, grew in Cox' mind a new and original interpretation of the software crisis and its causes as well as a programme for coming to terms with it.[168] Cox now contrasts the sad state of software construction with that of other branches of engineering and finds a striking difference in the lack of software production chains:[169]

> *Unlike the hardware industry, which has organized itself into a fully elaborated rainforest of mutually interdependent structure of production trees, the software industry remains stuck in the unicellular, bacterial stage of the primordial ooze.*

But why is it so? What makes software different? Cox explains:[170]

> *The primal cause of the software crisis is the breakdown in human incentive structures originating from the problematics of buying, selling and owning goods made of bits.*

Since software components are binary, immaterial goods that can be easily copied, it is utterly difficult to collect revenue for every point of usage. Instead, the developer of a component will sell his product to a small clientele of software development companies, which will then be able to duplicate it in their products without purveying any further gains to its originator. Thus, the lack of rational revenue mechanisms will effectively undercut the incentives for the division and specialisation of labour and, consequently, prevent the emergence of the production chains typical of mature areas of engineering. For this reason, the industrial revolution has not happened within software construction, which perforce is yoked to the habits of pre-industrial craftsmanship.

To counter the Iliad of woes that follow from the "breakdown in human incentive structures" Cox suggests *superdistribution,* a concept introduced already in 1983 by Ryoichi Mori, professor at the University of Tsukuba and chair of the *JEIDA (Japan Electronic Industry Development Association) Superdistribution Technology Committee.*[171] Mori suggests that software should be delivered in encrypted form to the user and then be decrypted through a special piece of tamperproof hardware, which will contain the decryption keys and a usage monitor. This hardware unit will regularly send billing information to a clearinghouse that will play a rôle reminiscent of that of a credit card company.[172] Programmes and components should, according to Cox and Mori, be given away for free and payment collected for usage in the same way as is done with, for instance, electricity or water. A piece of simplistic "meterware" code may implement the functionality needed:[173]

```
if (query(ProductID)) { /* query: is the user a paid up customer? */
    DeliverService();
    commit(ProductID); /* commit: record delivery */
} else
    DenyService();
```

---

[168] These ideas were first published in [Cox92]. They have since been restated and refined in a number of articles ([Cox93], [Cox94], [Cox95], [Cox97], and [Cox02]) and in Cox' extraordinary book [Cox96]. See also http://www.virtualschool.edu, a web site where Cox presents his own ideas and various relevant materials.

[169] [Cox95]

[170] ibid.

[171] According to Mori, the idea behind the term *superdistribution* is that *superdistribution* will make information flow without resistance just as *superconductivity* makes electrons do. See [MK90], [Mori89], [Mori90], and [Thor93]. Cf. also [TNG92].

[172] Metering and billing do not require an omnipresent communications channel, but can be accomplished through modem connections or even via floppy disks, which are sent to the clearinghouse organisation on a regular basis. Mori has constructed prototypes of the hardware needed called *S-boxes*. Similarly, [Szyp98a] p. 341 suggests that smartcards should be used to authenticate the user and provide electronic cash or credit information.

[173] [Cox95]

Service will be denied, if the hardware unit is not present, if usage has not been duly reported to the clearinghouse in the past, or if the bills due have not been paid. Many different payment models may be supported such as pay per keystroke/minute/hour/month/year or even traditional pay per copy. The clearinghouse organisation will be responsible for the reimbursement of the hierarchy of component providers in accordance to the usage of their components and any mutual contracts.[174]

1.3.4 SOME ALTERNATIVE VIEWS

Besides Cox' object-oriented notion of components, there were a few other attempts to take advantage of the component idea for the improvement of software development. Here we can only very briefly touch on this topic by discussing the influence of the component idea on the *Ada* programming language and on *software engineering.*

1.3.4.1 The Ada Component Programme

It has been claimed that the programming language *Ada,* according to its principal author Jean Ichbiah, was designed to facilitate a software components industry.[175] In his *IFIP* keynote speech in 1983, Ichbiah himself somewhat more gingerly stated that "Ada … was designed for a time when software development can be expected to be increasingly more distributed and when software systems can be expected to be assembled from independently produced software components."[176] He then goes on to associate the *package* and *generics* facilities of *Ada* with the software component vision of McIlroy. Although Ichbiah had become aware of McIlroy's component ideas already in 1969[177], there is no clear evidence that the component perspective was very influential on the design of *Ada* – there is, for example, no mention of it in *Rationale for the Design of the ADA Programming Language.*[178] The aptitude of *Ada* for component programming will rather have been added as an afterthought, or as Ichbiah put it himself in correspondence with the present author: "The preface is always done last."[179] Nevertheless, the *package* concept, which is pivotal in *Ada,* descended from the *LIS* language and its *partition* concept[180], which was introduced into *LIS* by Ichbiah already in 1971 and, thus, was conceived rather soon after McIlroy's famous speech and, in any case, predated the *module* concept of *Modula.* Some years later, Grady Booch formulated and forcefully promulgated an *Ada* component programme mainly concerned with low-level components for commonly used data structures and algorithms.[181]

1.3.4.2 Software Components in Software Engineering

Within *software engineering* and in particular within its subdomain *software reuse,* the term *component* is regularly understood in a way that fundamentally diverges from the one studied in the previous section. In these circles, *component* is used very broadly, denoting almost any type of "building block". A typical example of this usage, excerpted from one influential book on *software reuse,* is this definition:[182]

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[174] Also Miller and Drexler [MD88b] prefer a charge-per-use policy for software built of components instead of the usual charge-per-copy approach, in which they see a major barrier to general reuse. In fact, when they make this point, they refer to [Cox86]. [Szyp98a] p. 340 et seq. discusses some potential problems with this approach. Already [Nels74] p. 71/DM58 pondered copyright and royalty issues for computer-distributed pieces of information in the context of his *Xanadu* system.

[175] See [Bowl83]. Cf. also [Wegn83] p. 31, [Whit96] p. 219 et seq. and [Barn89] p. 4.

[176] [Ichb83]

[177] [Ichb98]

[178] [IHRB+79]

[179] [Ichb98]

[180] See [IF77].

[181] See [Booc87] p. 7 et passim. In his first *Ada* book [Booch83], Booch did not refer to components at all, not even in his treatment of the software crisis, its causes, and possible antidotes. [US90] is another collection of low-level *Ada* components, and in [Jaza95] a similar programme for *C++* components is advocated and elucidated with examples from the *C++ Standard Template Library (STL).*

[182] [Karl95] p. 255. See also e.g. [Same97b] p. 68 and [Krue92] p. 141 et seqq.

A reusable component is any component that is specifically developed to be used, and is actually used, in more than one context.

Some reuse authors have an even broader interpretation of *component* and subsume elements such as specifications and designs under the *component* umbrella term.[183] *Software architecture,* which basically is a branch of the *software engineering* tree, has, quite naturally, adopted this rubber-band understanding of what a *component* is, as exemplified by the above quotation.[184]

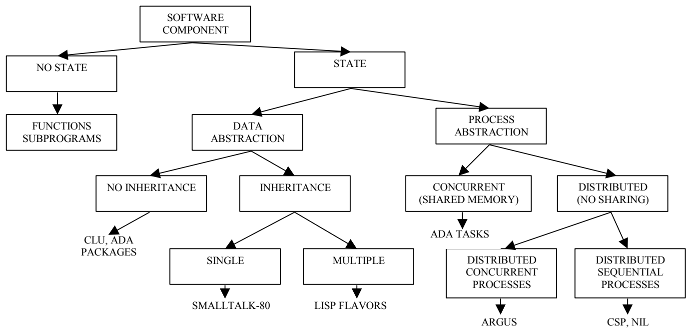

Figure 1. Wegner's taxonomy of software components

The usage of the term *component* in this wide sense can be traced back to the first half of the 80s – and, in particular, to the 1983 *ITT Workshop on Reusability in Programming* –, when reuse issues first began to attract widespread attention, much helped by the aforementioned *STARS* effort.[185] In this context, the term *component* came to take on the rôle of the abstract building block, which is the unit of reuse. Wegner made a taxonomy of such components[186] (see *Figure 1),* and others followed suit.[187]

[183] So e.g. [Coul98] p. 51 et seqq. The most extreme example of this liberal view of components will be the omnium gatherum of component types found in [McCl97] p. 204 et seq.

[184] See [BCK98] p. 23. [KCAB97] proposes *architectural element* as a term, which subsumes both *component* and *connector,* the two fundamental elements of architectural design.

[185] Cf. [DRR83]

[186] [Wegn84] p. 22. Wegner's broad notion of a component was adopted and further widened by the *Object Systems Group* at the University of Geneva. See [NT95] p. 4 et seqq. and [NM95a-b] where mix-ins, functions, macros, procedures, templates, interfaces, protocols, modules, packages, frameworks, generic configurations, and even architectures are looked upon as *components.* Many others have also adapted this view, including [Booc87] p. 36 et seqq. and [Same97b] p. 117 et seqq. During the 90s, several attempts have been made to restrict the realm of components based on the usage prevalent in commercial component technologies, but no general consensus about this usage has been reached. Some quite aberrant forms of usage of the word *component* exist as well, as that found in [Jack75] p. 15, where programming language instructions are called *elementary components* and the *sequence, iteration,* and *selection* constructs *composite components.*

[187] These include [Booc87] p. 36 et seqq. and more recently [KCAB97] and [Same97b] p. 117 et seqq.

1.3.5 SOFTWARE COMPONENTS TODAY

Brad Cox did not invent object-oriented reuse, but he formulated it as a programme and linked it to the *software component* idea.[188] By his insistence on the dynamic properties of *Software-ICs,* he established the notion of a component that still essentially prevails and has been adopted by commercial component technologies such as *COM/COM+/OLE/ActiveX, .NET, SOM/OpenDoc, CORBA,* and *JavaBeans/Enterprise JavaBeans*, although these also add sundry refinements and variations to the original theme. Important points of variation include the degree of language-independence and support for inheritance, and among the noteworthy additions are, for example, support for multiple interfaces, interface negotiation, outgoing (event) interfaces, distribution, and introspection. Furthermore – and by far most importantly – components have been given a face.

1.3.5.1 The Visualisation of Components

GUIs and object-orientation have been siblings from the very outset, and the notion of on-screen elements as objects or components suggests itself naturally.[189] Bill Atkinson's *Macintosh*-based *HyperCard* system, introduced in 1987, applied object-orientation to user interface construction by investing users with the ability to associate event handlers written in the *HyperTalk* script language with on-screen items such as buttons, fields, cards, backgrounds, and stacks.[190] At about the same time, the *Andrew Toolkit,* a framework for building and combining visual components for compound documents, was developed at the *Information Technology Center* of *Carnegie-Mellon University.*[191]

The *HyperCard* event handler was, as it were, cross-fertilised with the *Software-IC* idea in *NeXT's Interface Builder.*[192] This tool, being part of the much-hailed *NEXTSTEP/OPENSTEP* development environment for *Objective-C* programming, lets the programmer select an interface object such as a button, text field, or table from a *palette* and drag it into a window.[193] He may then resize the widget object, change its attributes through an *inspector window,* and connect its associated events with method invocations, *actions,* on *targets,* i.e. objects wired to the *outlets* of the interface object.[194] New palettes may be provided by third parties, and objects may be added to existing palettes.

Microsoft's Visual Basic environment and its *VBX (Visual Basic eXtensions)* components simplified and refined the approach introduced by *HyperCard,* the *Andrew Toolkit,* and *InterfaceBuilder*. The upshot was a new forms-based *RAD (Rapid Application Development)* style of programming.

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[188] Reuse is in a sense ingrained into object-oriented programming. Already back in the 60s, *SIMULA* came with a number of reusable classes, the *SIMSET* and *SIMULATION* packages (see [Birt69]), and reuse of pre-defined classes is the very nerve of the *Smalltalk* programming style. According to [Magn91], there is a tradition within the Scandinavian school of object-orientation to regard modelling as the main benefit of object-orientation and consider reuse of minor significance or even potentially harmful. Early discussions of reuse from an object-oriented point of view include [Deut83], [Deut89], [Wegn83] p. 33 et seqq., [Wegn84] p. 19 et seqq., and [Meye87].

[189] See [Coll95] p. 32 et seqq.

[190] See [Will87] and [Kaeh88]. Cf. also [Coll95] p. 439 et seqq., [Niel95] p. 19 et seqq., and [NTMS91].

[191] See [PHKS+88] and [Hans90a]. The desktop metaphor, the document-centric interface, and compound documents were all pioneered in the *Xerox Star* workstation. Today's commercial distributed object and component technologies – including *CORBA, COM/OLE,* and *OpenDoc* – largely rose from the pursuit of compound documents. See [SIKV82], [JRVS+89], and [Wats96a].

[192] [Myer96] p. 5 mentions some precursors to the modern interface builder, including software developed in the *Steamer* project at *BBN* [SRS83], *Xerox' Trillium* [Hend86], Bill Buxton's *MenuLay* [BLSS83], the resource editor of *Macintosh,* and Jean-Marie Hullot's *SOS Interface* for the Macintosh [Hull86]. Hullot was later hired by *NeXT* and designed its *InterfaceBuilder*. Cf. also [Card88a]. According to [Cox98], there were also links between *Stepstone* and *NeXT*. [Elli91] hints at a relationship between iconic simulation development environments, such as Bill Budge's *Pinball Construction Set* released in 1982, and interface builders.

[193] See [OHE96b] p. 319 et seqq. and [TB88]. More technical details are found in [Novo92] and [Crai97] p. 73 et seqq.

[194] An *outlet* is an *Objective-C id* variable, i.e. a handle that may identify any type of object.

1.3.5.2 The Commercialisation of Components

> *Object technology failed to deliver on the promise of reuse. Visual Basic's custom controls succeeded. What role will object-oriented programming play in the component-software revolution that's now finally under way?*
>
> *Jon Udell*[195]

Udell's opening phrase in the *BYTE* 1994 *ComponentWare* conspectus has become a *locus classicus,* quoted more or less *de rigueur* by component advocates. Indeed, the forms-based programming style introduced by *Microsoft's Visual Basic* and its *VBX* components in 1991 soon became immensely popular and, hence, conducive to the success of the *Windows* platform.[196] Not only did it bring benefits like enhanced developer productivity, reduced time-to-market, and trimmed-down project staffing demands, but, like *HyperCard,* it endowed new categories of people – who never would even think of doing traditional programming – with the ability to create advanced *GUI* applications. In short, *RAD* made *Windows* development cheaper and more predictable – and *Windows* programme supply richer.

VBXs created the first component market of any size. In 1998, the market for its scion technology, the *ActiveX* controls, was estimated at $670 million by the *Giga Information Group* and the number of commercially available *ActiveX* controls was stated to be 6000 by a *Microsoft* representative.[197] Although the *VBX/ActiveX* technology was instrumental in creating the success of *Windows,* it was also dependent on the omnipresence of the *Wintel* platform for its own success. Only the immense popularity of *Windows* was able to occasion the birth of a component market in the teeth of the breakdown of commercial incentives pointed to by Cox. In spite of the lack of means for revenue collection from *end-users,* the market of *Visual Basic* and other *RAD developers* has grown large enough to support a small number of component suppliers. Still, construction of *ActiveX* components is hardly a royal road to prosperity, and the $670 million's worth of the entire *ActiveX* market only covers the costs of two *Titanic*-sized movies and represents a very slight share of the total revenues of the software industry, estimated at $253 billion in 1996.[198] Although many other component types have subsequently been introduced, geared towards, for example, *Java* programming, *Internet* client- or server-side use, or transaction processing, the markets for these late-comers on the component arena will currently be, at best, minute.

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[195] [Udel94a] p. 46

[196] See footnote 70 on p. 19. The forms-based programming style of *Visual Basic* has been adopted in some other more or less successful *Windows RAD* development tools such as *Borland's Delphi, Centura's SQLWindows, Oracle's PowerObjects,* and *Powersoft's PowerBuilder.*

[197] [Leac98]

[198] According to statistics from the *Information Technology Industry Council (ITIC,* see http://www.itic.org) quoted in [Micr98u].

1.3.6 COMPONENT SHAPE FROM A HISTORICAL PERSPECTIVE

At the beginning of the 90s, Brad Cox extended the hardware-software analogy implicit in the *Software-IC* notion through a scheme of five "levels of integration", as illustrated in *Figure 2.*[199] The elements of each level are shown at the right side of the figure, and the degree of support for the levels in different programming languages is indicated by the pie slices. Gate and block-level components both imply tight coupling, but at the gate level, binding is done at compile-time, whereas at the block-level, it may be delayed until link or even load time. *Software-ICs* and *Smalltalk* objects are building blocks at the chip-level. Here and at the higher levels, loose coupling is essential, and binding is delayed until run-time. Additionally, objects at the card-level have their own thread of control, whereas rack-level objects are independent programmes with their own separate address spaces.

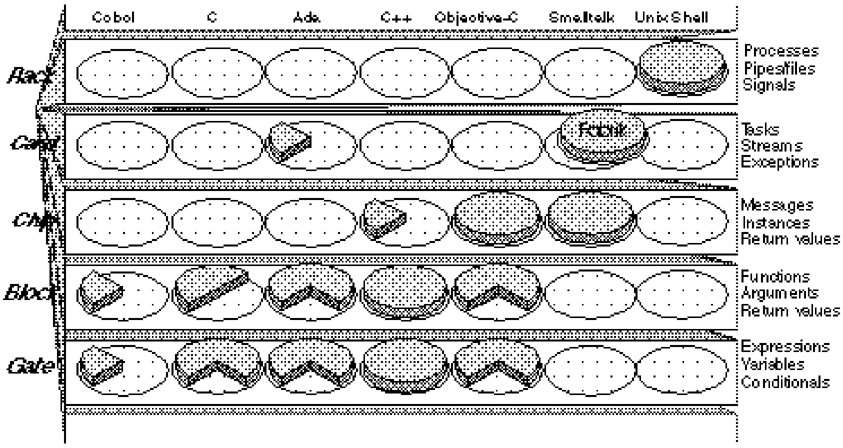

Figure 2. Brad Cox' hierarchy of integration levels (courtesy of Brad Cox).

Ordinary subroutines as well as the packages of *Ada* belong to the block-level and so do the objects of statically typed languages like *C++, Java, Eiffel,* and *SIMULA,* although these also have some share in the chip-level by virtue of their virtual function members.[200] Dynamically bound objects, such as those of *Smalltalk* subsist at the chip level as do Cox' *Software-ICs* and present-day *COM* and *JavaBeans* components.

Later Cox revised his scheme somewhat as shown in *Table 1.* He now speaks of "five architectural levels", which he contrasts with the common two-level model of operating system and programming languages.[201] In the new scheme, there is a marked rift between the tightly-coupled block/gate-levels, and the loosely-coupled upper levels. The former are essentially *fabrication* technologies, useful for low-level construction efforts made by *experts,* whereas the chip, card, and rack levels provide *assembly* technologies, which could be combined with iconic representations to create visual assembly environments appropriate also for the common run of *end-users.*[202] Cox likens the difference between the chip and block levels to that between open and closed systems

[199] [Cox90a], [Cox90b], [Cox91], and [CN91] p. 49 et seqq.

[200] Of late, reflective techniques have been used to make the shackles of static binding less oppressive. Variants of this theme are used in *JavaBeans,* in the dynamic invocation facilities of *CORBA,* and in the dispatch interfaces of *COM/OLE* in order to reconcile the capability for dynamic discovery of interfaces with statically typed languages such as *Java* and *C++*.

[201] [Cox96] p. 75 et seq. On p. 106, Cox states that also gate level objects encapsulate their own state and behaviour, although other parts of his discussion reflect the opposite view that they indeed share state and behaviour. Here I have found it useful to adopt the latter view that gate level entities are shared.

[202] As examples of visual card-level programming environments, Cox mentions *Fabrik* (see [IWCL+88]) and *Metaphor.* In [Cox91], he describes his own *Objective-C TaskMaster* library for building asynchronous card-level objects.

in physics. When the border between the block and chip level is traversed, safety and efficiency are traded for loose coupling, flexibility, and openness.[203]

	State	Behaviour	Thread of control	Address space	Type checking	Binding	Data com/ exchange	Object types
Process (rack)	Encapsulated	Encapsulated	Encapsulated	Hardware protected	Dynamic	Dynamic	Asynchronous/ values only	Process, programme
Task (card)	Encapsulated	Encapsulated	Encapsulated	Shared	Dynamic	Dynamic	Asynchronous/ values & references	Task, thread, co-routine, *CBO*
Chip	Encapsulated	Encapsulated	Shared	Shared	Dynamic	Dynamic	Synchronous/ values & references	Component, object, Software-IC
Block	Encapsulated	Encapsulated	Shared	Shared	Static	Load time or earlier	Synchronous/ values & references	Object, module, package, subroutine
Gate	Shared	Shared	Shared	Shared	Static	Compile time	Synchronous/ values & references	Expression, statement, macro, variable

Table 1. Cox' five architectural levels of "objects"

The two visions adumbrated above fit neatly into this scheme: McIlroy's *mass-produced components* belong to the block-level[204], whereas Cox' *Software-ICs* subsist at the chip-level. Historically, a motion upwards has taken place within Cox' model from low-level, tightly knit systems towards higher-level, loosely coupled agglomerations of objects or components. The most important driving force for this motion will be a long-standing thrust towards interactivity, augmentation of man's capabilities, and user empowerment.[205] The itinerary meanders from the introvert, machine-oriented style of computing of the 50s and 60s, over the interactive terminals of the 70s, towards today's extravert, user-oriented fashions of *personal* computers and graphical *user* interfaces.

Whereas McIlroy's *mass-produced components* and the traditional vehicles of reuse, such as function libraries, *APIs,* and object-oriented frameworks, are entirely introvert, intended as building blocks for programmers, Cox' *Software-ICs* fall somewhere between the introvert and extravert extremes. They started life as an object-oriented revision of the introvert paradigm, but have since gravitated towards the visual and the end-user. Still, components of, for instance, the *ActiveX, .NET,* or *JavaBeans* breeds remain essentially programmer-oriented: They are supposed to be used as building blocks when constructing basically monolithic applications, rather than as independent items to be manipulated and combined by plenipotentiary end-users.

It can be argued that the motion upwards in the Cox diagram will not stop at the chip level, i.e. that components, or even visual components, are not the end of history. Hence, the investigation of different card-level *shapes* should prove a profitable direction of research. Vaticination is a risky business, but it is the belief of the present author that one promising card-level development is the *Cooperative Business Object (CBO)* devised

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[203] Of late, reflective techniques have been used to make the universe of statically typed languages less closed. Variants of this theme are used in *JavaBeans,* in the dynamic invocation facilities of *CORBA,* and in the dispatch interfaces of *COM/OLE* in order to reconcile the capability for dynamic discovery of interfaces with statically typed languages such as *Java* and *C++*.

[204] The packages of *Ada* also belong to the block-level and so do the objects of statically typed languages like *C++, Java, Eiffel,* and *SIMULA,* although these also have some share in the chip-level by virtue of their virtual function members.

[205] [Kay93], [Coll95] p. 19 et seqq., [Pres93], and [Myer96] provide historical surveys of this trend and its roots. See also [Gold88]. The theoretical ramifications of interactivity have recently started to become debated. See [Wegn95a-b], [Wegn97], and [Ekda99].

by Oliver Sims.[206] *Cooperative Business Objects* are coarse-grained, loosely coupled, independently executable, *bona fide* objects representing real-world concepts and interacting through *Semantic Data Streams*. Such *CBOs* transcend the software chip analogy by being considerably more extravert and user-oriented in nature than present-day components and will essentially appear as independent mini-applications or *rack objects* to end-users.[207] For various reasons, including performance concerns, *CBOs* do not generally encapsulate their own thread of execution, although they will shield the programmer from threading and synchronisation concerns.[208] In addition, they support both asynchronous and synchronous messaging, so to the programmer they will in fact appear as *card objects*. When I started my thesis work and made up the plans for the *Panopeus* project, I imagined that something like Sims' *CBOs* might become the clarion call of tomorrow. In a later section, the notion of "business objects" will be studied at length.[209]

[206] [Sims94]. See also [Sims95a-b] [Sims96a-g], [Sims97], [Sims98], [ES98], [HS00], [SSA97a-c], and [SSA98]. A succinct exposition of *Sims'* ideas and their implementation in the *Newi* system can be found in [OHE96b] p. 325 et seqq.

[207] *Agents* are card-level entities closely related to *CBOs*. See [Bake97a].

[208] *CBOs* are reactive in nature, and their actions usually descend from some kind of user interaction, creating a "flurry" of messages that propagate between *CBOs* within one thread. However, if synchronous messages are sent from one *CBO* to another, there is a risk that recursive synchronous messages may create deadlocks. Thus, if a recursive message is sent when the *CBO* is waiting for an outbound synchronous call to return, it is the responsibility of the *CBO* infrastructure to detect this and create another thread within the *CBO* receiving the synchronous message. Additionally, when an asynchronous message is sent, the receiver must use a thread separate from that of the sender. In spite of such niceties, conceptually each *CBO* may be regarded as executing within its own well-encapsulated thread of execution.

[209] See p. 109 below.

1.4 SOFTWARE COMPONENT INFRASTRUCTURES

For the adumbrated vision of software construction as the assembly of ready-made *components* to come to life, some kind of infrastructural support, i.e. a *component technology,* will obviously be needed.[210] In this section, a number of such *component technologies* will be briefly surveyed and analysed. A newcomer to components may easily become baffled and estranged by the sheer bulk and complexity of these commercial component technologies – it might seem both perturbing and paradoxical that mechanisms advertised as a means of reducing complexity and enhancing productivity should by themselves be so utterly large, complex, and time-consuming to come to terms with. But to make the complexity-reducing, reuse-boosting components so much sought for materialise, rich and complex infrastructures are, as we will see, indeed needed, and infrastructure is what really accounts for the bulkiness of today's component technologies.

1.4.1 WHAT IS A COMPONENT INFRASTRUCTURE?

The various elements of a component and distributed object infrastructure can be grouped into four levels or layers, viz.:

- An *object bus* consisting of
  - an *object model* defining the fundamental shapes and properties of objects by specifying the key characteristics, such as the data types supported, the rules for object naming, the inheritance types supported, the exception handling schemes adopted – if any – and a plethora of other properties and features
  - an *object request broker (ORB)* technology making it possible to freely distribute objects across process, network, and language boundaries
- A number of low-level *object services,* more or less necessary to make the distribution of objects/components work. The core services will encompass life cycle handling, naming, persistence, event handling, licensing, and security, but there may be a plethora of more specialised services as well.
- A few more complex, high-level *facilities,* geared not primarily towards *objects/components,* but towards *applications* and *documents*. The most important kind of facility will be a *compound document architecture,* enabling the tight *GUI* integration needed by component software.
- *Components* of different shapes, built on top of the lower levels.

This will serve as a reasonable, albeit provisional and imperfect, working model, by which most of today's component and distributed object technologies may be analysed, although there are other possible hierarchies as well.[211]

1.4.2 COMPETING TECHNOLOGIES

The four by far most widely used and complete component infrastructures, *Microsoft's COM/ActiveX,* its successor *.NET, OMG's CORBA* and *CORBA Component Model (CCM),* and *Sun's Java Beans/Enterprise JavaBeans* differ both in scope, insofar as they address different portions of the spectrum of component usage, and in their degree of independence of languages and language paradigms, operating systems, and network proto-

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[210] Most of the more specifically *technical* works on software component technology – i.e. works not primarily taking a software engineering view of components, such as [Same97b], [Brow00], [ABBK+02], or [WHS02], an analysis and design view, such as [AF98], [DW99], [SP00], or [Whit02], or a business organisation and management view, such as [Very01] – deal only with a specific component technology, such as *COM, .NET, OpenDoc, JavaBeans,* or *CORBA*. Only a few studies, such as [Szyp98a], [Grif98], and [OHE96b], are more general in scope and try to cover multiple component technologies. Additionally, [HC01] and [CL02], albeit primarily concerned with the software engineering aspects, also look into the technological issues at some length. [Ryan96], [Prit99], and [Emme00] cover multiple technologies, but are focused on distributed objects, whereas [Sera99] deals with middleware, [BK99] with object monitors, [Lint00] with enterprise application integration, and [HS98c] and [BenN97] with web programming. Cf. also [HS00].

[211] The above classification has primarily been borrowed from *OMG's Object Management Architecture* (see [OMG97a] and [SS95]), but much in the same spirit [Micr94] p. 4 divides *OLE* services into *infrastructure services* and *application features,* roughly corresponding to the service and facility layers of *OMG*.

cols. Although all four technologies have been advertised as "open", this purported "openness" will, as we shall soon see, need qualification for each of them. Somewhat simplified, one may say that the *Java* technologies, albeit taking up the fundamental component-oriented distinction between *interface* and *implementation,* remain strictly faithful to the traditional object-oriented programming paradigm and, being closely coupled to the *Java* language, retain something of the basic orientation towards web- and distributed programming characteristic of this language. Somewhat similarly, the *CORBA* specifications are primarily focused on *distributed objects* and *middleware* and the *CORBA* products chiefly target such market segments as *UNIX* and mixed environment "technical programming", although *CORBA,* though object-oriented in its general design, is not closely coupled to any special programming paradigm, nor to any language or operating system, but can be used on a plethora of platforms and from a wide range of both object-oriented and other languages, such as *C, COBOL,* or even *LISP* and *PL/1*.

Microsoft's COM provides the most clear-cut attempt to establish "component-orientation" as a programming paradigm on its own, distinct from traditional object-orientation – in fact, this attempt can be construed as having been even further radicalised through *COM+, Microsoft's* adaptation of *COM* for transaction processing and load balancing middleware.[212] However, *COM* was from the start strongly biased towards the personal computing paradigm and, of course, presupposes a commitment to *Microsoft's* operating environments, the so-called *Wintel* platform. Significantly, *COM* also turned out to be ill equipped for the new rules of the game instituted by the *Internet* revolution, as witnessed by the rather limited success for the *ActiveX* components on *Internet* despite *Microsoft's* rather passionate efforts to promote it in the mid-90s. The *.NET* technology can be viewed as *Microsoft's* response to the challenge provided by the *Internet* and, in particular, the *Java* language and the *JavaBeans* component model, a response largely worked out on the basis of the experiences garnered from *Microsoft's* own implementation of *Java* in the *Visual J++* product with its (almost) seamless integration with *COM.*[213] It implies the renouncement of the *COM/ActiveX* view of component-orientation as a paradigm fundamentally different from object-orientation and the acceptance of the *Java*-like *virtual machine* style of execution as the inescapable upshot of the *Internet* revolution. For rather obvious strategic – as well as various other – reasons, *Microsoft* cannot accept the vision touted by *Sun* of the total predominance of a ubiquitous *Java* language designed and controlled by *Sun,* but has reacted to this vision by generalising the *Java VM* approach into a multi-language virtual machine approach, thereby securing the consent not only of the numerous long-time users of *Microsoft's* own popular development environments, but also of many usually *Microsoft*-sceptic designers, advocates, and users of other, more or less exotic, languages than *Java*.

In addition to the above technologies, there exist various examples of proprietary component technologies, mostly predating the above ones. *Next's PDO (Portable Distributed Objects)* and the proprietary *ORB* technology used in the *Newi (New World Infrastructure)* business object system owned by *SSA (System Software Associates)* provided two examples of such proprietary technologies, both, however, now demised. More recently, the open source *Bonobo* component technology has been launched by the *GNOME (GNU Network Object Model)* project as an "open source" alternative to the more well-established commercial technologies.[214]

It is also possible to implement some aspects of a component infrastructure within a language. *JavaBeans* are, of course, such programme components supported directly by the *Java* language. Additionally, an *ORB*-like feature called *Remote Method Invocations (RMI)* is part of the *Java* infrastructure. The *Component Pascal* (formerly *Oberon)* language developed by Niklaus Wirth's group at *ETH* in Zürich also provides support for the component-oriented programming style.[215]

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[212] Cf. [Box98b].

[213] See below p. 551.

[214] On *Next's PDO,* see [Crai97] p. 119 et seqq. and [OHE96b] p. 313 et seqq. On *Newi,* see below p. 142. On *Bonobo,* see [Meek01] and http://www.gnome.org/gnome-office/bonobo.shtml.

[215] On the *Java* component technologies, see below p. 85. On *Oberon,* see [WG92], [Möss95], [Pfis97b], and http://www.oberon.ch.

1.4.3 OBJECT REQUEST BROKERS

The purpose of an *object request broker (ORB)* is to facilitate the distribution of objects across processes, machine-boundaries, operating systems, networks, and programming languages. Accordingly, *ORB* technology can be viewed as an object-oriented counterpart of the *RPC (Remote Procedure Call).* A client of an object accessed through an *ORB* does not have to care about the whereabouts of the object, which programming language it is written in or the network protocols and *IPC (Inter-Process Communication)* methods used when accessing it – all such details are made transparent by the object request broker. A strict division of *interface* and *implementation* is the key to achieving this goal and is one key characteristic that sets *component-oriented programming (COP)* apart from traditional *object-oriented programming (OOP).* The principles of how an *ORB* works will now be briefly outlined.

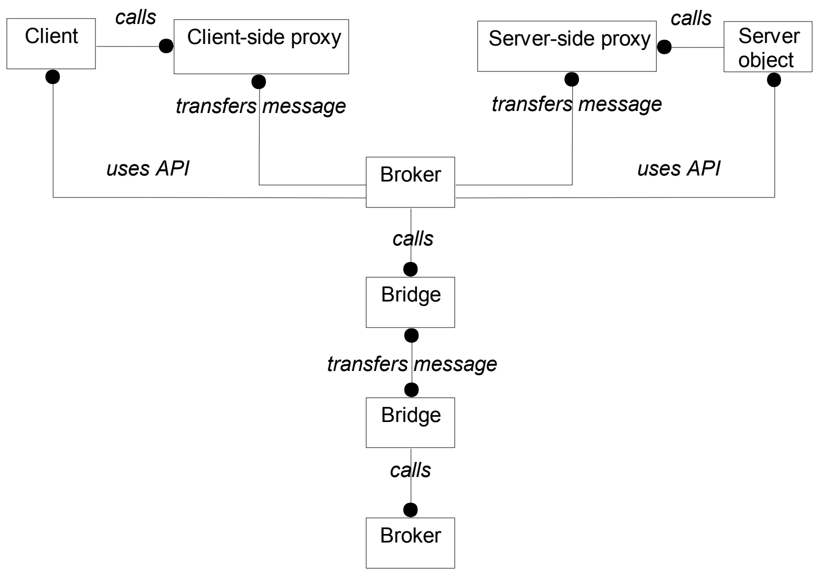

Figure 3. The constituent parts of an object request broker

As shown in *Figure 3,* the client of a distributed object calls methods in a *proxy* object representing the distributed object, rather than in that object itself. This proxy resides in the same process as the client, and to the client it looks exactly like the remote object by virtue of its exposing the very same *interfaces* as the remote object. When a method is called in the proxy, the proxy object will package the name of the method as well as any argument values into a machine- and network-independent format in order to avoid problems caused by having different representations of characters, integers, and floating-point numbers etc. on the different machines involved in the call. This packaging is referred to as *marshalling.*

The marshalled package will then be handed over to the *broker,* which is responsible for finding the remote object. This is usually done by a search in some form of repository. The broker will then check whether the remote object is already running, otherwise it will have to activate it. This done, the package received from the client-side proxy will be furthered to the server-side proxy. This proxy will unpackage or *unmarshal* the method name and argument data and then call the appropriate method in the object proper with the unmarshalled arguments.

When the server method has terminated its execution, it may pass a return value, a number of out parameters, and, in case of a failure, an exception to the server-side proxy. The proxy will marshal these data

and send them back to the client-side proxy[216], which will then unmarshal them and return them to the caller. Except for the execution time overhead, the remote call is entirely transparent to the client.

It is also possible to introduce *bridges* into the model. Bridges make it possible for brokers using different protocols to communicate with each other.[217]

There are four major *ORB* technologies around: *CORBA (Common Object Request Broker Architecture)* from the *Object Management Group (OMG), COM/DCOM (Component Object Model* and its distributed extension *Distributed Component Object Model)* and *.NET Remoting* from *Microsoft,* and *Java's RMI Remote Method Invocation)* facility. Presently, there exists a rather great number of commercial and public domain object request brokers advertised as *CORBA*-compliant. Originally, the providers of commercial *CORBA*-compliant *ORBs* tended to fall into either of two categories: large, well-known computer manufacturers and small up-starts specialising in *ORB* technology. Among the most significant products originating in the former group were *DSOM (Distributed System Object Model)* and *ComponentBroker* from *IBM, NEO* from *Sun, HP ORB Plus* from *Hewlett-Packard, DAIS* from *ICL,* and *ObjectBroker* from *Digital.* All these *ORBs* have now been discontinued, sold off to other companies, or integrated into some kind of more general middleware product.[218] The latter group has created some of the most popular *CORBA*-compliant *ORBs,* such as *Orbix* from *IONA, VisiBroker* from *Visigenic,* and *PowerBroker CORBAPlus* from *Expersoft.* These products have proved somewhat more lasting, although *Visigenic* has become part of *Inprise/Borland* and *Expersoft* has been acquired by *Vertel,* which calls its ORB product *e*ORB.*

Microsoft's DCOM is also a *bona fide*, albeit of course not *CORBA*-compliant, object request broker, permitting objects to be freely distributed across a network. *COM,* on the other hand, although being the basis on which *DCOM* has been built, does not by itself allow objects to be distributed over multiple machines, but only across process-boundaries on the same machine.[219]

1.4.4 THE OBJECT BUS – SOME ISSUES

The design of an object request broker may vary in many respects. A few points of such divergence will now be briefly discussed.

1.4.4.1 The Object Model

At the heart of the object bus is an *object model,* defining the basic properties of the objects on this bus. In particular, the question of which reuse mechanism is preferable for the object model of a component infrastructure was the subject of considerable altercation in the mid-90s. In this fray, one of the most heatedly debated issues was whether components are to support implementation inheritance – as is the case in traditional object-oriented programming languages – or polymorphism rather ought to be achieved by some form of *composition* such as *aggregation* or *containment.*[220] This debate was pursued mainly by the advocates of *IBM's SOM (System Object Model)* and *Microsoft's COM (Component Object Model).* Whereas *COM* was often blamed by its critics for its lacking support of inheritance, although it does actually support (single) interface inheritance, *SOM* boasted of support for (multiple) implementation inheritance, albeit at the cost of considerable complexity. *CORBA,* with which *SOM* was claimed to be compliant, neither requires nor rules out support for implemen-

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[216] The values may be returned directly from the server-side proxy to the client-side proxy or indirectly via the broker, depending on the *ORB* implementation.

[217] [Sieg96] p. 88 et seqq. discusses *CORBA* bridging at some length. Bridges may be used for other purposes than protocol conversion as well, such as *policy mediation,* i.e. content-based filtering of network traffic.

[218] For example, *Digital's ObjectBroker* has been integrated into *BEA's WebLogic* middleware suite and *ComponentBroker* has become part of *IBM's WebSphere* family, whereas *ICL's DAIS* has been sold off to *PeerLogic,* which is now part of *Critical Path.* See [Sieg00] p. 473 et seqq. The reader taking an interest in the history of *CORBA* products should also have a look at the issues of the now discontinued *CORBA Buyer's Guide,* such as [OMG97k].

[219] On *DCOM,* see [BK96].

[220] These terms will be explained in p. 49.

tation inheritance, but specifies that multiple interface inheritance is to be supported. Also *Microsoft's .NET* supports multiple interface inheritance – as well as single implementation inheritance.

Whereas *interface inheritance* (or *subtyping)* is basically a – in the main wholly uncontroversial – way to extend a *specification* (also known as a *type* or an *interface),* not intrinsically related to code reuse, *implementation inheritance* (or *subclassing)* is a means to reuse, modify and extend the *code* of another implementation. Reuse through implementation inheritance is referred to as *white-box reuse,* because it makes parts of the innards of parent classes visible to their subclasses and more or less compels the programmer who reuses the class to acquire knowledge of these innards. The fact that the use of implementation inheritance exposes the implementation details of a base class to its children has often been censured: Inheritance is said to break encapsulation.[221] This breaking of the barrier of encapsulation may create implicit interdependencies between parent and child, which may seriously complicate software updates, particularly if the parent and child classes are not controlled by the same company or institution, something that will happen much more frequently in the world of components and distributed objects than in traditional object-oriented programming. The problems involved may be exemplified by the infamous *fragile base class problem*[222] adduced by *Microsoft* as the main reason why implementation inheritance was abandoned in *COM.*

```
class A {
public:
  void X(void) { Y(); ... }
  virtual void Y() { ... }
  ...
};

class B: public A {
public:
  virtual void Y() { ... }
};
```

Assume that we have a base class A and child class B: In this case, the Y method of class B may make class A break, since it is called from the X method in the A class. This fragility of A::X stems from the possibility of X's being dependent on a certain behaviour of the Y method, such as a modification of object state, in order to be able to execute as intended. To be able to implement Y correctly and safely, the implementor of B will need access to the source code of A. And if the implementation of A should be changed, there is a risk that B::Y will no longer work correctly. Although the above case is often adduced in *Microsoft* literature, there are many other variants of the fragile base class problem as well.[223]

Composition is a reuse mechanism that may be used as an alternative to implementation inheritance. Since it does not break the seals of encapsulation, composition is sometimes referred to as *black-box reuse*. In *COM,* composition is the only reuse mechanism available and two variants of it known as *containment* (or *delegation)* and *aggregation* are used. With reference to *COM,* these terms are used in a slightly different way than in ordinary object-oriented terminology.

Containment or *delegation* takes quite a simplistic approach to reuse.[224] One *COM* object, known as the *inner object,* is, as it were, contained in another *COM* object, the *outer object,* and the outer object exposes and imple-

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[221] Cf. [Snyd86]. See also below p. 233.

[222] [Broc95] p. 96 et seq., [WK94] appendix 1, [PS94], [OHE96b] p. 451 et seq., and [Pfis97b] ch. 3.4. Cf. also [BRMS+96] p. 46 and [GHJV94] p. 18 et seqq. [MS97a-b] and [MS98] provide an in-depth analysis of the fragile base class problem and also suggest some rules that, if observed by both base and child class designers, will "solve" the problem. However, to be able to abide by the rules, child class designers need detailed source code-level knowledge about the base class to be extended or revised and, in particular, about its self-call recursion patterns. See below p. 232 et seqq.

[223] As pointed out by [PS94], [Szyp96], [MS97a], and [Pfis97b] there is both a *semantic* and a *syntactic* fragile base class problem. In fact, [MS97a] discusses five different cases of the problem. Whereas the above example illustrates the former, semantic problem, the latter will arise when changes are made to the interface of a base class, thereby forcing child class implementations to be recompiled – and possibly redesigned as well. As exemplified by *IBM's SOM* (see [Lau94] p. 73 et seqq. and [IBM94c]), the syntactic fragile base class problem may be alleviated somewhat by doing method dispatch and instance data access through data structures put together at run-time. *COM* addresses (and eliminates) the problem by the prescription that interfaces be immutable.

[224] A distinction between *forwarding* and *delegation* is sometimes made in object-oriented literature. *Forwarding* is understood as a simple forward call of an inner method from an outer one, whereas *delegation* denotes a call where a pointer or reference to the outer object is

ments the same interfaces as the inner one – as well as other interfaces, of course. In most cases, each method in the delegated interfaces of the outer object is implemented as a simple forward call to the corresponding method of the inner one, although it is perfectly possible for the delegating method to perform any supplementary actions it needs.

Aggregation in *COM* is used to avoid all the wearisome interface duplication and forwarding code implied by containment as described above and to get a little performance improvement to boot.[225] This is done by directly exposing the interfaces of the inner object, which is simple enough by virtue of the interface negotiation mechanism *(QueryInterface)* of *COM* which will be explained below (see p. 58). While conceptually elegant, *aggregation* is, however, riddled by a number of sombre complications, which has made its use less frequent than one might *prima facie* expect.[226]

The *CORBA ORB* specification does not support composition or interface negotiation,[227] although work on a "multiple interfaces and composition" specification was formerly in progress within *OMG*. However, the *CORBA Component Model (CCM)* specification includes support for both composition and multiple interfaces called *facets*.[228]

The implementation inheritance controversy has rather wide-ranging philosophical implications, insofar as the support for implementation inheritance, the linchpin of object-orientation, could be taken as an indication of whether component-oriented programming is to be considered an extension or variant of object-oriented programming or a new programming paradigm in its own right. With time, the latter view, for long advocated by *COM* enthusiasts, slowly seems to have gained momentum amongst the cognoscenti.[229] However, in *.NET,* the latest incarnation of *Microsoft's* component technology, support for (single) implementation inheritance has indeed been introduced, thereby, however, also compelling the programmer to grapple with class fragility considerations.[230] It remains to be seen if *Microsoft's* capitulation on this count indeed will have brought in the final verdict on the matter.

1.4.4.2 IDL-Based or Binary Language Mappings

Ultimately, the object model must be mapped into existing programming languages. This can be done in either of two ways: One approach is to devise a *binary* standard that somehow must be supported by programming language implementations so as to allow for the use of the interfaces of components and remote objects within ordinary programmes – *Microsoft's COM* is basically such a binary standard based on the *vtable* construct.[231] Alternatively, mappings from a high-level *IDL* language to different languages may be defined, making it possible to tailor the implementation of the object model to the language used. In this case, the interface designer must declare the interfaces of distributed objects in *IDL* files, which he may then compile into source code – or perhaps binaries – in sundry languages by taking advantage of *IDL* compilers specific to the language mappings used. This is the course taken by *CORBA,* although the range of items created by a *CORBA IDL* compiler varies somewhat between the different *CORBA* brokers. Typically the created items

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added to the parameter list of the inner method in order to make it possible for the inner method to adjust any references to *this* from the inner object to the outer one. This distinction is not made in *COM* literature, where *delegation* is understood as simple forwarding.

225 The usage of the term *aggregation* in *COM* does not have much in common with the meaning attached to it in object-oriented analysis and design, where the concept of *aggregation* is usually used to signify a part-of relation in contrast to looser forms of relations between objects, often referred to as *associations*. See e.g. [RBPE+91] p. 57 et seq.

226 The interested reader should refer to [Broc95] p. 103 et seqq.

227 See [OMG02a] p. 18-26 et seqq.

228 See [Sieg00] p. 141 et seqq. See also [OMG02b].

229 See, for example, [Box] and [Pfis97b].

230 See [Baro02], [Chap02] p. 149 et seq., and [Plat02] p. 41 et seqq. In a later section of this work, I will discuss how the fragility problems can be overcome by a somewhat novel programming style, which I call *encapsulated programming*. See below p. 228.

231 See p. 57.

will include stub and skeleton code[232] and, possibly, import files for the interface repository, the *CORBA* counterpart of *COM* type libraries.

Microsoft also has an *IDL* language for *COM,* but its purpose is not to bring about language independence.[233] In fact, *IDL* declarations are not essential to *COM,* since *COM* is a binary standard based on the *vtable* construct. Nevertheless, it is for a number of reasons often convenient to use *Microsoft's IDL* language to declare one's interfaces, viz. in order to:

- automate the generation of the proxy and stub code for marshalling, which otherwise would have had to be handcrafted[234]
- create type libraries, which might be useful for a number of purposes, the most common of which will be support for automation (i.e. *dispinterfaces).*[235]

COM's IDL dialect is largely an extension of the *IDL* used for *Microsoft's RPC,* which, in turn, is a variant of *OSF's DCE RPC.* It should be noted that many popular programming tools, such as *Microsoft's Visual Basic,* free the *COM* programmer from having to care about *IDL* files. In *.NET,* the need for *IDL* programming has been removed altogether, as the metadata needed to support reflection and build proxies are generated for all objects automatically by the compiler.

1.4.4.3 Static and Dynamic Invocations

In addition to *static invocations,* i.e. hard-coded method calls given in the source code of the client of an object, *dynamic invocations* may be supported. Dynamic invocations are constructed and issued at run-time, for example as strings to be passed to certain broker *API* functions. For dynamic invocations to be feasible, it must be possible to extract type information about interfaces, methods, and parameters from a type information repository, probably by means of some broker *API* functions. Dynamic invocations are used to implement, for example, scripting/automation and inter-ORB bridges and gateways.

1.4.4.4 Invocation Semantics

Different kinds of method *invocation semantics* may be supported. The most common form of method invocation is *synchronous,* implying that the caller of a method will block until the method returns. If the call is *asynchronous,* the caller will not wait for the method to finish its execution and, consequently, may not expect any value or error information to be returned. There may also be support for a *deferred-synchronous* method call type, which allows the caller to continue executing after the call has been made as well as to check for a response from the method called by using some suitable technique, such as, for instance, polling.

1.4.5 SERVICES AND FACILITIES

In addition to the basic *object request broker* functionality of the object bus, a number of *object services* are needed to make the universe of distributed objects come to life. Common object services address such issues as life cycle handling, naming, event handling, persistence, transactions, object query, security, and licensing.

Whereas the *service* layer concerns individual objects on a rather low, fundamental level, *facilities* are more complex and pertain to applications or documents and other higher-level constructs rather than individual objects. The *compound document architecture* is often considered the most important facility, but there may be others as well, such as facilities for system management, agents, or workflow. The division line between

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[232] In *CORBA* parlance, *stub* is a client-side and *skeleton* a server-side proxy.

[233] [Majo99] is a specialised treatment of *Microsoft's IDL.*

[234] In *Microsoft's* terminology, *proxy* denotes a client-side and *stub* a server-side proxy.

[235] See p. 52 below.

services and facilities is by no means clear-cut, the classification of certain technologies as services or facilities by no means being carved in stone. One particularly important facility, often considered an integral part of *compound document architectures,* is *automation,* which facilitates the programmability of applications.

1.4.5.1 Compound Document Architectures

The most important full-blown *compound document architecture* available today is doubtless *OLE (Object Linking and Embedding)* from *Microsoft,* being a crucial part of the *COM* infrastructure. *OpenDoc,* which was developed jointly by *IBM, Apple,* and some other companies under the auspices of the *Component Integration Laboratories (CIL),* was advanced an "open" alternative to *OLE* in the mid-90s, but was discontinued in early 1997. Both of these technologies include approximately the same type of functionality:

- *structured storage*, implementing files capable of storing different types of data in a tree structure internal to the file
- *uniform data transfer*, a technology needed to implement clipboard and drag and drop functionality
- *automation,* allowing late-bound scripting interfaces to be created and dynamically discovered at run-time, thereby facilitating programmability of components and applications
- *compound document management,* including support for
  - *linking,* allowing the creation of links from data in one document to an area in another document – the documents will be separately saved and updated and the link may be broken if the document linked to is moved or deleted
  - *embedding,* viz. of data of a foreign type inside a document – in contrast to what happens when linking is used, the foreign data will be saved together with its container document, typically in a structured storage file
  - *in-place activation,* allowing an embedded or linked part of a document to be directly edited inside its container document in such a way that, during the editing of the embedded or linked portion, the container application will change menus, toolbars, toolboxes and kindred paraphernalia to those of the native application of the edited area

1.4.5.2 Automation

One important feature of many applications today is *programmability,* which lets the application expose some or all of its functionality through a *programmatic interface.* A programmatic interface may take the form of a proprietary *macro language,* but although this approach may be useful in many cases, it lacks generality as well as the benefits that come from standardisation. Furthermore, it does not generally make it possible to control multiple applications – or even a single one – from an external programme written in an ordinary, popular programming language, such as *C++, Java* or *Visual Basic,* let alone to dynamically discover and use interfaces by the intelligent use of type information.

A more general way of providing late-bound, cross-application programmability is *automation,* which is a technology providing the needed support for *scripting languages,* a kind of simple, interpreted programming languages designed to control other applications. Well-known examples of such scripting languages are *Visual Basic for Applications* and the web-oriented *JavaScript* (also known as *JScript)* and *VBScript* languages. Programmes written in scripting languages, taking advantage of the programmatic interfaces of other applications, are usually referred to as *scripts* and are frequently used to automate repetitive tasks, which, of course, presents us with the rationale of the choice of the term *automation* as the designation for such technologies. Automation is usually considered an integral part of a *compound document architecture,* being supported both by *Microsoft's OLE* and the defunct *OpenDoc* from *Component Integration Laboratories.* In addition, a *CORBA Scripting Language* speci-

fication has been adopted by *OMG*[236]*,* and *Microsoft's .NET,* just like *Sun's Java,* will be able to supply similar functionality through its support for *reflection*.

Automation (originally known as *OLE Automation)* is a substantial and important part of *Microsoft's* component technology, even sporting its own reference manual.[237] In addition to the core programmability mechanisms, usually referred to as *dispatch interfaces*, various helper technologies can be considered parts of *Automation,* such as the *COM type information* and *type library* facilities.[238] *COM* objects with one or many *dispatch interfaces* are referred to as *automation objects, ActiveX objects,* or, at times, *programmable objects,* and applications implementing and exposing such objects are called *automation servers.*[239] An application that understands how to control other applications through their automation objects is known as an *automation controller.* Among the most widely used automation controllers are the *Microsoft's Visual Basic* and *Visual Basic for Applications (VBA)* interpreters. An application that is designed throughout so as to make it possible to be driven by external controllers through *Automation* is sometimes said to be *programmable.* For example, *Word, Excel* and the other applications of *Microsoft's Office* suite are all *automation servers* designed to be programmable.

To illustrate how *Automation* works, a snippet of *Visual Basic* code using *Microsoft Excel* to print out a spreadsheet is given below:

```
Dim ExcelApp As Object
Set ExcelApp = CreateObject("Excel.Application")
ExcelApp.Workbooks.Open("Kalle på Spången.XLS")
ExcelApp.Workbooks.Worksheets("Sheet1").Activate
ExcelApp.Workbooks.ActiveSheet.PrintOut
```

In the *CreateObject* call, an application and a top-level *automation object* of this application, typically its *Application* object, are referenced in the form of a human-readable text string (without any spaces, which in this case happens to be critical), which is known as a *programmatic identifier* or, to be more exact, a *version-independent programmatic identifier,* used to identify the *automation server* indicated, in this example *Microsoft Excel.*[240] The part of the run-time system of *Visual Basic* implementing an *automation controller* will have to convert the ensuing piece of code into various *OLE API* calls and method calls on the *IDispatch* interface, which is the interface used to implement *dispatch interfaces* in *COM.*[241]

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[236] See [OMG01c].

[237] See [Isem00a] vol. 4. Earlier versions were [Micr96a] and the second volume of [Micr94]. See also [Broc95] p. 635 et seqq. and [Chap96b] p. 85 et seqq.

[238] Other such helper technologies will be the rather comprehensive *COM APIs* intended for the handling of the *SAFEARRAY, BSTR,* and *VARIANT* data types and various type conversions as well as the *ODL (Object Description Language)* interface definition language originally used when creating type libraries, but rendered obsolete by the extensions made to the *Microsoft IDL* language in the mid-90s.

[239] This terminology was abolished by *Microsoft* in the mid-90s as explained by [Chap96b] p. 91 et seq., but is still rather widely used. *Microsoft* then started talking about *automation objects* as simply *objects* or *ActiveX objects.* In addition, *automation servers* were renamed *ActiveX components acting in the role of servers,* and *automation controllers* were called *ActiveX components acting in the role of clients.* In this new terminology, however, the parties involved are not required to supply programmability through *IDispatch,* but any mechanism may be used, although *IDispatch* will still be the method of choice. In spite of these terminological quibbles and shifts of vogue, the well-known and – in the humble opinion of the present author – more clear-cut concepts of yore will be stuck to in this thesis.

[240] A *programmatic identifier* is a kind of human-readable name, which may be associated with a unique identifier called a *CLSID* through entries in the *Windows* registry. A *programmatic identifier* has the form:

```
<vendor>.<component>.<version>
```

Often the vendor name is replaced by a product name, as was done in the *Excel* example above. The version-independent variant lacks the version number part. The *Visual Basic* run-time converts the *version-independent programmatic identifier* `Excel.Application` into a unique *CLSID* by calling the *OLE API* function *ProgIDFromCLSID,* which looks up this *programmatic identifier* in the *Windows* registry in order to find the corresponding *CLSID*. The *CLSID* found, *CoCreateInstance* is called in order to activate *Excel* and create its *Application* object, which is then queried for an *IDispatch* pointer through *QueryInterface.*

[241] To be able to employ *IDispatch::Invoke* to call the methods of the *dispatch interface* of the *Application* object, the *Visual Basic* interpreter must firstly learn about the *dispIDs* of these methods. This can be done by calling *IDispatch::GetIDsOfNames* with a method name, e.g. `Workbooks`, or by taking advantage of type information through *IDispatch::GetTypeInfo,* provided *IDispatch::GetTypeInfoCount* indicates that such type information is available. If type information is at hand, the *automation controller* should also use it to perform necessary type checking and type coercion on the method arguments before calling *IDispatch::Invoke.* If no type information is to be had, *IDispatch::Invoke* will have to accomplish these tasks itself. See below p. 60 et seqq. for a description of the *IDispatch* interface and its methods.

1.5 *MICROSOFT'S COM, COM+, OLE, ACTIVEX,* AND *.NET*

The roots of *Microsoft's* component technologies, just as those of the *Object Management Group,* are to be found in the quest for a compound document architecture, and *Microsoft's* first attempts in this area date from about the same time in the late 80s as *OMG* was formed. But whereas *OMG* adopted a bottom-up approach, starting out by defining a comprehensive low-level infrastructure before going on to the more complex tasks of designing a compound document architecture and other advanced features, *Microsoft* set out in a top-down manner, developing their compound document architecture *OLE (Object Linking and Embedding)* on top of the – rather weak – infrastructure available at the time in the shape of the *Windows* asynchronous communication protocol *DDE (Dynamic Data Exchange)* and basing the *VBX (Visual Basic Extension)* programme components for their new *Visual Basic* programming environment not on top of a distributed object infrastructure, but on messages sent through the *Windows* message loop.

For all their faults, these new technologies, the *VBX* components introduced in 1991 together with *Visual Basic 1.0* and the *OLE compound document architecture* launched together with the *Windows 3.1* in 1992, were certainly instrumental in creating the success of *Windows*. *OLE 1* made *Microsoft's Excel* and *Word* and some other products interoperate, although in a somewhat sluggish and inelegant way, and the *VBX* components and the forms-based *RAD (Rapid Application Development)* programming style quickly rendered *Visual Basic* one of the most popular programming environments in the world. In any case, *Microsoft* soon started working on a total revision of these technologies, substituting a true component infrastructure, the *Component Object Model (COM),* for the previous weak underpinnings of *OLE*. As a result, *OLE 2* followed upon *OLE 1* already in 1993, and in 1994 *OLE Controls* or *OCXs* were introduced as the successors of the *VBXs*. About the same time *Microsoft* removed the version number from *OLE* and made it known that *OLE* was no longer to be regarded as an acronym, but as a name for *Microsoft's* entire component integration technology.[242] Since its introduction in the early 90s, *Microsoft* has constantly been adding new features and technologies to its component infrastructure, which soon became a key element of *Microsoft's* business strategy.

In early 1996, *Microsoft* introduced yet another designation, *ActiveX,* initially denoting a number of new *OLE*-based technologies specifically adapted to the *Internet*. Soon, the label *ActiveX* started to be used in a more general sense and replaced *OLE* as an umbrella term for *Microsoft's* component technologies, whereas *OLE* once again became a designation for the compound document parts of these.[243] Later on in 1996, the distributed version of *COM, DCOM (Distributed Component Object Model),* was introduced as a part of the *Windows NT 4.0* operating system, supplying *Microsoft's* component infrastructure with a distributed object request broker technology comparable to *CORBA*.[244] Subsequently – and in particular after the advertisement of *COM+,* the next generation of *Microsoft's* component technology, at the *Microsoft Professional Developers Conference (PDC)* in September 1997 –, the term *COM* again became the preferred general designation for *Microsoft's* component endeavour, whereas *ActiveX* tended to be increasingly restricted to *Microsoft's* new *Internet*-oriented technologies and the *ActiveX Controls,* i.e. the kind of visible programme components earlier referred to as *OLE Controls* or *OCXs,* although lately this term has all but fallen into desuetude even in this context.

On 17 February 2000, a first version of *COM+,* which largely is an attempt to unify *COM* with the *Microsoft Transaction Server (MTS)* and, thus, primarily geared towards middleware and transactional componentry, was officially released together with the *Windows 2000* operating system.[245] In June this same year, *Microsoft* also unveiled the plans for its upcoming *.NET* technology, which, at least partly, can be viewed as yet another evolution of the *COM* infrastructure, originally being code-named *COM+ 2.0*.[246] Amongst other things, *.NET,* of which a first version was released together with *Microsoft's* development environment *Visual Studio .NET* in early 2002, features a *Common Language Runtime (CLR)* – obviously largely inspired by *Java's*

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[242] [Broc95] p. 11

[243] Cf. [Chap96b] p. 4.

[244] See [BK96].

[245] As per October 2002, the current version of *COM+* is 1.5.

[246] See [Box00]. The term *.NET* is also used in a more general sense by *Microsoft* about its strategic product lines. For example, the *SQL Server, Biztalk Server, Commerce Server, Content Management Server, Exchange Server, Host Integration Server 2000, Internet Security and Acceleration Server 2000,* and *SharePoint Portal Server 2001* are referred to as *.NET Enterprise Servers*. These servers, which earlier were marketed under *Microsoft's DNA* and *DNA 2000* banner, are, however, not based on *.NET* technology, but the *.NET* branding of them is to be understood as a pure marketing gimmick. See [Chap02] p. 34 et seqq.

virtual machine – and the concept of *managed code,* which together make it possible to provide support for automatic memory and version management of components, name space handling, cross-language class inheritance, cross-platform just-in-time compilation, code access security, and various other features. There is, obviously, little rigour in *Microsoft's* usage of all these terms, which is largely guided by marketing and other non-technical concerns, so what is intended by using one term or the other, is really highly dependent on the context as well as on who is speaking. Below, I will primarily use *COM* as the umbrella term and restrict the use of the other terms in keeping with the usage in *Microsoft's* technical documentation.

In the main, *Microsoft's* component technologies are closely linked to the *Windows* platform, which itself, besides, is becoming increasingly dependent on various aspects of *COM.* Work has also been done to port crucial portions of *COM* to other platforms such as *Apple's Macintosh*[247], various *UNIX* platforms[248], and some mainframe and mini computer platforms, including *OpenVMS, OS/400,* and *OS/390.*[249] For example, *Software AG* has ported *ActiveX/DCOM* to *Solaris, Digital UNIX, Linux,* and *OS/390.*[250] *Compaq* provides versions of *COM* for its *Tru64 UNIX* and *OpenVMS* operating systems, whereas *Microsoft* itself provides a version for *Sun's Solaris.*[251] As part of its *Wind/U* product, which is available for a large number of *UNIX* platforms, *Bristol Technology* includes support for a large range of *COM, OLE,* and *ActiveX* functionality.[252] It should be noted that none of these ports covers the *COM* infrastructure in its entirety and that the exact extent of the supported features varies considerably between the different platforms and products.

In an attempt to address the objection about *COM* being an essentially proprietary technology, *Microsoft* already in 1996 submitted the *ActiveX* core technologies to the *Open Group* so as to make these available for licensing, validation, and branding on other platforms than *Windows.*[253] In October, 2000, *Microsoft* likewise submitted the specifications of the *Java*-like *C#* language and the *CLI (Common Language Infrastructure)* subset of the *.NET Framework* to *ECMA* for standardisation, and in December, 2001 both these specifications were ratified by *ECMA.*[254]

1.5.1 *COM* AND *.NET* BASICS

COM, the *Component Object Model,* is presently the foundation of *Microsoft's* entire component endeavour, which is also, as pointed out above, often referred to by the term *COM.*[255] Just like *CORBA, COM* rests on a

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[247] This work was made by *Microsoft* in co-operation with *Macromedia* and *Metrowerks*. See [Micr96h].

[248] *Microsoft, Bristol Technology, Mainsoft, Digital Equipment/Compaq, Hewlett-Packard,* and *Software AG* have all been involved in such efforts.

[249] *Bristol Technology* and *Software AG* worked on these ports together with *Microsoft*.

[250] See http://www.softwareag.com/natural/add%5Fon/naturalx.htm, http://www.softwareag.com/entirex/download, [Maut96], and [Micr97u].

[251] For more details, see http://www.tru64unix.compaq.com/com, http://www.openvms.compaq.com/openvms/products/dcom, and http://www.microsoft.com/com/resources/solaris.asp.

[252] See http://www.bristol.com/windu/index.html.

[253] See [Micr96i]. As a manifestation of this effort, the *Active Group* was formed under the auspices of the *Open Group* and *Microsoft* announced its intention to supply specifications and source code reference implementations for the *ActiveX* core technologies. The core technologies to be supported included *COM/DCOM, Microsoft RPC, NTLM Standard Security Provider Interface (SSPI),* structured storage, registry, moniker, and automation functionality. Judging from its stale web link http://www.activex.org, the *Active Group* is no longer very active, but instead the *COMsource* initiative of the *Open Group* has supplied "an open systems implementation" of *COM* for *Solaris* and *Tru64 UNIX*. The features supported in the release version 1.0 are reported to be "COM (including DCOM, Service Control Manager, Structured Storage, Monikers and Automation), MS-RPC, Registry, and the Windows NT Distributed Security provider" (see [Open99c], [Open01], and http://www.opengroup.org/comsource).

[254] *CLI* is essentially the specification of the multi-language virtual machine implemented by the *Common Language Runtime* part of *.NET*. See [Micr01a-b], [Micr02a], and [ECMA01a-b].

[255] The literature on *COM, OLE, ActiveX, COM+, .NET* and the various more specialised *COM* technologies, which also are part of the *Microsoft* component infrastructure, is very large. Besides the bulky *Microsoft* documentation, most easily accessible via the *MSDN (Microsoft Developer Network)* web site http://msdn.microsoft.com, but also available in various printed versions, such as [Micr94] and [Isem00a], Kraig Brockschmidt's hefty tome [Broc95] will be indispensable to any serious student of *COM,* albeit now out of print and somewhat dated. [Broc96] is an illuminating article on the basic ideas behind *COM* by the same author. Of related interest are also the articles [Will88a-b] and [Will90a] by Tony Williams, the chief architect of *COM* and *OLE*. [Chap96b] provides an unusually lucid introduction to *ActiveX* and *OLE* by David Chappell, an author of many articles (see http://www.chappellassoc.com/articles/index.html) with a focus on the strategic issues of software componentry. More recently, he has produced the also eminently readable books [Chap00] and [Chap02]

strict division between *interface* and *implementation,* but, unlike *CORBA, COM* supports the notion of objects that expose multiple interfaces. The account below will be based on classic *COM,* but will also take into account the recent advancements and additions provided by *.NET.* These original *COM* basics, albeit now destined to grow increasingly obsolete, still remain of interest both in their own right and because *COM* will continue to be used on *Windows* machines for the foreseeable future. In any case, the *COM* basics must be grasped by anyone who wants to appreciate the later evolutions of *Microsoft's* component technology properly. A later section will be specifically devoted to *COM+,* of which the most significant new features primarily target middleware, or to be more specific, transaction processing componentry.[256]

The new *.NET* technology has, through the introduction of the concept of *managed code* and the addition of the comprehensive object-oriented *.NET* framework, on which the *.NET* programmer will rely for various common tasks, been able to dispense with many of the special features – and difficulties – of *COM* programming discussed below, rendering component programming less exotic and much easier – and also more similar to "run-of-the-mill" programming and the style of *COM* programming offered for long by languages such as *Visual Basic* and *Visual J++*. This is accomplished by running *managed code* – such as *.NET objects, components,* and *controls,* i.e. the new, post-*COM* generation of components – inside a *Common Language Runtime (CLR),* a kind of virtual machine, which handles many of the issues that the *COM* programmer had to address explicitly, such as, for example, memory management and version handling.[257] *COM* components are packaged in executable files, *DLLs (Dynamic Link Libraries)* or *EXE* files, and so are *.NET* objects, but a *.NET DLL* or *EXE,* which is referred to as a *portable executable (PE),* is very different from a *COM DLL* or *EXE,* insofar as it does not contain binary, directly executable code, but code in an intermediary representation known as *Microsoft Intermediate Language (MSIL)* as well as various metadata, which replace and improve on the *COM* type libraries. Consequently, this *MSIL* code will have to be transformed into native code by a *just-in-time compiler (JITter)* before it can be executed, and, as one may guess, the price for this trick and all the versatility provided by the *CLR* is paid in performance and programme size.[258]

1.5.1.1 Interface Naming

Every *COM* interface has two names: The one is human-readable, by convention usually beginning with an *I,* as, for example, the standard interfaces *IUnknown* or *IDispatch.* This human-readable name is primarily used by programmers for type specification purposes in their programme code. Notably, such type names are not guaranteed to be unique, as they are invented by programmers, who may well happen to come up with the same name twice.

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on *Windows 2000 Distributed Services* and *.NET,* respectively. A somewhat similar perspective is provided by Roger Sessions in his books [Sess98a] and [Sess00b] and numerous articles and analyses in the *ObjectWatch Newsletter* (see http://www.objectwatch.com) and elsewhere, but with a more definite emphasis on middleware and server-side technology. The strategic, architectural, and design aspects are also focused on in [Kirt99] and [BBCE+00]. More programming-oriented works are [Roge97b], which describes "classic" *COM* more concisely than Brockschmidt, [Denn97], which provides an authoritative account of the *ActiveX Control* technology, and [Plat98], [Plat99], and [Plat02], a suite of useful books on *COM/ActiveX, COM+,* and *.NET* respectively, authored by David S. Platt, a technical expert in this field (see also http://www.rollthunder.com/newsletter.htm for Platt's newsletter *Thunderclap).* For the technically advanced reader, Don Box' writings, including the two books [Box98a] and [BBES99], will be very instructive. In addition to the already referenced works, see [EE99], [Gord00], [Ober00], [Patt00], and [Tapa01] and the early articles [Kirt97a-b] on *COM+* (and largely also *COM);* [EE98a], [Redm97], [Pinn98], and [Grim97] on *DCOM;* and [CDFG00+] and [DDLN+02] on *.NET.* In addition, [BBC01] provides a pattern-based approach to *COM* and *COM+* design and programming. A large number of more specialised books published by *Microsoft Press, Wrox Press, Prentice Hall PTR,* and others also offer useful assistance to the student of various aspects of *Microsoft's* component technologies; some of these will be referenced below.

[256] See below p. 609. *COM+* includes support for three new services, viz. the *dynamic load balancing capability,* the *queued components service,* and the *publish and subscribe events services.* A fourth service, the *in-memory database (IMDB),* which was part of the beta version of *COM+,* was removed from its release version. In *.NET,* the *COM+ services* are referred to as *Enterprise Services;* see [Jaco02] and [Chap02] p. 214 et seqq.

[257] [Goug01] compares *CLR* with the *Java Virtual Machine (JVM).* In contrast to *JVM*, *CLR* has been specifically designed for just-in-time compilation and is not suited for interpreted execution.

[258] Each method in a *PE* module is *just-in-time (JIT)* compiled into native code immediately before it is executed for the first time – the second time it is called it will of course not need to be re-compiled. However, the resulting native code is not saved to disk, but the *MSIL* code must be re-compiled every time an assembly is loaded into memory, although there is also an option to compile the *MSIL* code of an assembly into native code by means of a *Native Image Generator (NGEN).* Notably, *MSIL* was not designed so as to support interpretation.

Thus, in addition, every interface must be assigned a unique *IID* (interface identifier), and the *IID* must be used by the programmer when he interacts with the *COM Library* or else when uniqueness is essential. A unique *IID* may be extracted by running a utility programme, which might be called *UUIDGEN.EXE* or *GUIDGEN.EXE,* or by calling a *COM API* function. An *IID* is an example of what in *COM* parlance is known as a *GUID (Globally Unique Identifier),* which is a 128-bit (16-byte) integer adhering to the *Universally Unique Identifier (UUID)* standard [259], which is part of the *Distributed Computing Environment (DCE)* from the *Open Software Foundation (OSF).* A typical *GUID* may look like this, presented in the *DCE* standard form for spelling it out:

550E8400-E29A-11D0-A619-444553540000

In *.NET,* the need for *GUIDs* has been done away with by the introduction of *namespaces* with class names such as *System.Windows.Forms.Control*, which will make name collisions unlikely and comparatively easy to resolve. However, in some contexts *.NET* uses *strong names,* another kind of unique identifier.[260]

1.5.1.2 The Vtable Interface Standard

Interfaces in *COM* are always accessed through interface pointers. An interface pointer is a pointer to an object, the first element of which is a pointer to a *vtable,* i.e. a table of pointers to functions (also referred to as methods) implementing the functionality of the interface. Such is the *COM* binary *vtable* standard.

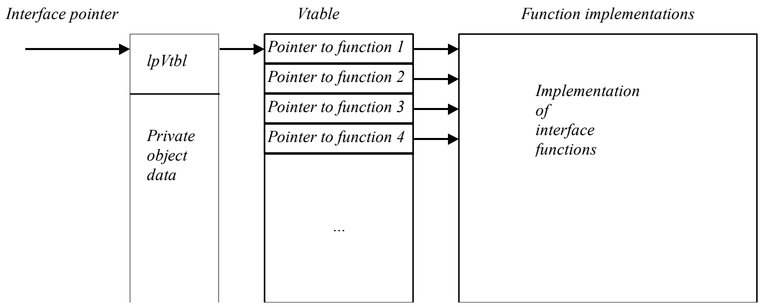

Figure 4. The vtable binary standard

Although the described construction may seem a bit convoluted, it is actually the way methods in classes are implemented by *Microsoft's C++* compiler as well as many other *C++* and object-oriented language implementations. Consequently, if you use *C++,* the methods of an interface are called in exactly the same way as methods of any regular *C++* object. If, however, a language like *C* is used, the *vtables* will have to be handled explicitly, which hardly is an enjoyable task, and if your language of choice does not support pointers to functions, you will not be able to use *COM* objects at all, unless the supplier of your language implementation provides some kludge in order to support *COM* in one way or other. Obviously, there is a built-in bias in *COM* towards *C++* and languages with the same *vtable* layout as *C++,* as, for instance, *Microsoft's* implementation of *Java* or its new *C#* language.

A *COM* object – also known as an *OLE* or *Windows* object – is an encapsulated entity accessed by clients through one or more interfaces, which it implements. *COM* supports single interface inheritance, but not implementation inheritance. All *COM* interfaces must inherit from the *IUnknown* interface, which supports the basic *COM* operations for interface negotiation and reference counting, which will be described below. It may

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[259] A *UUID* is constructed from the current date and time, a *clock sequence,* a counter, and an *IEEE* machine identifier *(MAC* address) obtained from the network card of the machine or, in case a network card is lacking, a randomly synthesised machine address. See [Broc95] p. 96.

[260] See [Chap02] p. 98 and [Plat02] p. 32 and p. 60. Obviously, the *.NET* namespaces have been moulded on *Java's package* concept.

seem limiting that *COM* only supports single inheritance, but since each *COM* object may implement any number of interfaces, this is not really much of an issue.

With the introduction of *.NET,* the programmer does no longer need to think in terms of the special *COM* programming model with its interface pointers and vtables, when he implements a component, but instead he works with the ordinary programming model of the *.NET*-compatible language he prefers. However, if he wants to create a *.NET* object or component that can interact with objects and components written in other languages, he cannot make free use of all the features of his language of choice in the interfaces he exposes to outside callers, but must take care only to expose features that are explicitly allowed by the *Common Language Specification (CLS)* and, in particular, only expose types that belong to the *CLS* subset of the *Common Type System* supported by the *Common Language Runtime (CLR).*[261] *.NET* code that complies with *CLS* is called *CLS-compliant.* Importantly, support for cross-language implementation inheritance, constructors, and structured exception handling has been added to *.NET* through the intermediation of the *CLR.*

All *.NET* objects ultimately derive from the class *System.Object.* A *.NET component* is a class implementing the *System.ComponentModel.IComponent* interface[262], which provides support for the design-time use of the component in a *RAD* tool, such as *Visual Studio.* Components that also have a run-time user interface are called *controls* and must derive from either the *System.Windows.Forms.Control* class, in case they are intended to be taken advantage of as client-side *Windows Forms* controls, or the *System.Web.UI.Control* class, if they will be used as server-side *ASP.NET* controls emitting *HTML* code to be interpreted by a web browser.[263] Finally, for a *COM* object to be used from *.NET,* it must be provided with a *runtime callable wrapper (RCW),* which can be generated automatically in *Visual Studio.NET* or with the tool *TlbImp.exe,* and, conversely, for a *.NET* object to become accessible from *COM,* it will need a *COM callable wrapper (CCW),* which is generated on the fly when the object is created through a call of *CoCreateInstance,* provided the *.NET* class complies with certain rules, such as having a default constructor and a registry entry.[264]

1.5.1.3 The IUnknown Interface

Every *COM* interface inherits the *IUnknown* interface[265], and, hence, every *COM* object must implement the *IUnknown* interface[266]:

```
interface IUnknown {
   HRESULT QueryInterface(IID &iid,void **ppv);
   ULONG   AddRef(void);
   ULONG   Release(void);
};
```

Through its three methods *QueryInterface, AddRef,* and *Release, IUnknown* adds two fundamental features to *COM,* viz. *interface negotiation* and *reference counting.*

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[261] See [Micr01c-d]. For example, pointers or variable parameter lists are not allowed in the interface of a *CLS-compliant* object.

[262] The easiest way to implement this interface is by derivation from either of the classes *System.ComponentModel.Component* or *System.ComponentModel.MarshalByValueComponent.* These classes provide support for marshalling by reference and by value respectively, thereby making the component remotable so it can be located in a different application domain (lightweight process), process, or machine from that of its caller. For nonremotable components, the programmer must implement the *System.ComponentModel.IComponent* interface himself.

[263] See [Plat02] p. 269 et seqq.

[264] See [Plat02] p. 55 et seqq.

[265] The strange name of this interface is explained by [Roge97b] p. 39: Since all interfaces inherit the *IUnknown* interface, it is unknown to a client, which has a pointer to *IUnknown,* what interface this pointer really points to – although it is, of course, possible to find out through a call of the *IUnknown::QueryInterface* method.

[266] The notation used follows Brockschmidt's "clean C++ style syntax" as explained in [Broc95] p. 75 rather than the daunting code style used in e.g. *Microsoft's OLE* header files. Please note that the keyword *interface* is *#define*d as a *struct.*

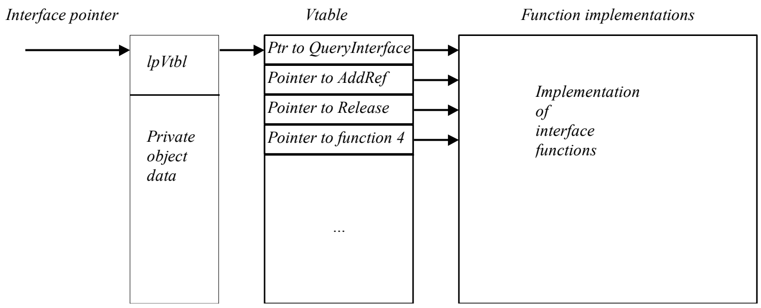

Figure 5. A COM vtable will always be laid out with the IUnknown methods first

Reference counting is a simple, albeit often awkward and error-prone, method for memory management, compelling each *COM* object to control its own lifetime by maintaining an internal reference count. Each time a new reference to a *COM* object is retrieved or such a reference is copied, *AddRef* must be called on the object. When the reference no longer is needed, *Release* must be called, and when the reference count drops to zero, the *COM* object should remove itself. The success or failure of this scheme depends entirely on programmer discipline, and there are a number of nasty complications that in some cases may make reference-counting turn into a real brainteaser.[267] In *.NET* "managed code", real garbage collection has been introduced and the programmer no longer needs to spend time on the tedious and treacherous chore of reference counting.

Interface negotiation makes it possible for a client to ask a *COM* object, if it supports a certain interface. This is done by the client's calling `QueryInterface(iid,ppv)` with the *GUID* of the interface as the first parameter. If the interface queried for is supported, the constant NOERROR is returned from *QueryInterface* and a pointer to the interface is returned in the *ppv* parameter; otherwise, an error code E_NOINTERFACE is returned. Since all interfaces inherit *IUnknown,* a client may always call *QueryInterface,* if it has a pointer to an interface of an object. And since a *COM* object may only be accessed through interface pointers, a client of an object always has at least one interface pointer, which references one of the interfaces of the object, if it knows of the object at all.[268]

The *QueryInterface* method makes it possible for a client of an object to dynamically adapt its behaviour to the functionality implemented by the object. It also makes versioning of *COM* objects easy: Since interfaces are immutable, what may change between different versions of a *COM* object or component is not the inter-

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[267] Such complications are nested interface pointers (see [Broc95] p. 85 et seqq.), circular reference counts (cf. [Broc95] p. 89 et seq.), risks of premature calls of *Release* during initialisation (could be countered by *artificial reference counting*, i.e. doing *AddRef* just before the risky code and *Release* immediately after it, as explained by [Broc95] p. 90), and the intricate rules for reference counting applying to aggregation situations (see [Broc95] p. 104).

[268] According to [Broc95] p. 95 et seq., there are three rules that any implementation of *QueryInterface* must comply with:

1. A request for a pointer to the *IUnknown* interface through a call of the *QueryInterface* of any interface on an object must always return the same pointer value, which is regarded as the run-time identifier of the entire object and, consequently, may be used in comparisons in order to determine if two identifiers refer to the same object. This rule does not apply to any other interface than *IUnknown*.

2. After an object has been instantiated, it must support the same interfaces during its entire lifetime. This applies only to the lifetime of a particular object instance, but not to an object class – different object instances of one and the same class may support different interfaces, but the set of interfaces of any instance may not change during its lifetime.

3. All implementations of *QueryInterface* must be reflexive, symmetric, and transitive:

    - reflexive: *pInt1->QueryInterface(IID_IInt1)* must succeed
    - symmetric: if *pInt1->QueryInterface(IID_IInt2)* succeeds, then *pInt2->QueryInterface(IID_IInt1)* must succeed as well
    - transitive: if *pInt1->QueryInterface(IID_IInt2)* succeeds and *pInt2->Query-Interface(IID_IInt3)* succeeds as well, then *pInt3->QueryInterface(IID_IInt1)* must also succeed.

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faces *per se,* but the set of interfaces supported by the object. If the client of the object is to be able to make use of a new interface in a new version of an object, it must, of course, have learnt of the interface in one way or other in order to be able to ask the object for it by calling *QueryInterface* with the correct *IID*. Clients ignorant of the new interface will not break, because they will not ask for the new interface and thus will not have to bother with it at all. And if an interface is removed in a new version of the object, its users will find out that it is no longer supported when they call *QueryInterface* and may take appropriate action.[269]

With *.NET* the simplistic *QueryInterface* version handling has been abandoned for a more robust model, which allows several versions of a component or object to co-exist. This is achieved through the introduction of *assemblies,* which are collections of files containing at least one *.DLL* or *.EXE* file, any number of supplementary files (such as bit maps and picture files), and a *manifest,* which specifies the files that are part of the assembly and itself resides in one of these. Assemblies intended for sharing amongst many applications reside in the *global assembly cache (GAC)* of the machine and must be given a *strong name* (also known as a *shared name)* as a kind of unique identifier.[270] The *manifest* of the assembly also includes a *compatibility version* number, which usually is generated automatically by a development tool. When a *.NET* client needs to access a certain assembly, the *Common Language Runtime* will load the correct version of it in keeping with a *publisher policy,* which specifies whether an exact version match is to be ensured, as is the default, or if the requested version is to be exchanged for another, specified version, as will be done for a *configured assembly.*[271]

1.5.1.4 More Interface Types – Dispatch and Outgoing Interfaces

In addition to the *vtable* type of interfaces described above, which usually are statically called, it is also possible in *COM* to create *dispatch interfaces* or *dispinterfaces,* which are dynamically invoked through the *Invoke* method of the *IDispatch* interface. Obviously, *vtables* match the *class* construct of *C++* quite well, and to the *C* and *C++* programmer the compile-time binding, which goes with the use of the *vtables,* will mostly be quite adequate. Unfortunately, *vtables* are not equally easily handled from all programming languages and environments. In particular, they do not sort well with interpreted scripting languages, such as *Visual Basic.* Additionally, in the distributed world of *DCOM* marshalling, code for any custom *vtable* interfaces exposed must be pre-installed on all clients, from which the interfaces may be called in the future, unless *dynamic marshalling* is supported, to implement which will be quite a daunting task and, thus, rarely undertaken, whereas such pre-installation is not necessary at all for *dispinterfaces.*[272]

If *vtable* interfaces seem to have been designed with *C++* in mind, *Microsoft's* dynamic *dispatch interfaces* or *dispinterfaces* were, initially at least, geared specifically towards *Visual Basic.* In fact, the *dispatch interfaces* technology was designed by *Microsoft's Visual Basic* group. It is used to implement *automation,* which is a way to make components and applications programmable through scripts by letting late-bound scripting interfaces be created and dynamically discovered at run-time. Applications that support automation are sometimes referred to as *automation servers,* whereas clients capable of controlling other applications through *IDispatch* are known as *automation clients. Automation servers,* such as *Word* or *Excel,* expose their services to *automation clients* through a number of *automation objects,* sometimes also referred to as *ActiveX objects* or simply as *objects.*[273] Such *automation objects* will expose *methods* and *properties* – and often also *events* through a mechanism described below.

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269 This simplistic type of version control is criticised in [OHE96b] p. 443 as "solving the versioning problem by not supporting it".

270 Every assembly is identified by its (textual) name, its version number, and its *culture* (supported language). The *strong name* includes these three elements as well as a unique digital signature. See [Chap02] p. 97 et seq.

271 See [Plat02] p. 34 et seqq. for more details.

272 Since all *dispinterfaces* are implemented through one single, standard *vtable* interface, *IDispatch,* all that is needed when a remote *dispinterface* is called is the proxy and stub of *IDispatch,* which are, of course, part of the *OLE* infrastructure. In fact, the *automation controller* and *automation server* will have to do much of the marshalling and unmarshalling themselves, when packing and unpacking the *VARIANT* structures used for parameter and result value passing, as will be described below. There is, however, an *OLE API* function, *DispGetParam,* which retrieves an argument after having done any necessary type coercion and, thus, may be of great help when implementing an automation object in *C/C++*. In *Visual Basic,* all the grubby details of the marshalling process are, of course, totally hidden from the programmer.

273 On *Microsoft's* volte-faces with reference to automation terminology, see footnote 239. There is a set of recommended *standard objects,* which, when implemented, provide a uniform way for *automation servers* to expose their functionality:

A *dispinterface* differs from a *vtable* interface in some respects. Firstly, besides *methods,* it supports *properties,* i.e. data items that a client may access directly in lieu of having to use access methods to get and put the values of the items. Secondly, every method and property must be assigned a *dispatch identifier,* or *dispID* for short, that uniquely identifies the item within the interface; *dispIDs* are not, however, *GUIDs* and are only required to be unique *within one single dispatch interface* and, as a matter of fact, are usually assigned consecutive values starting from 0 – 0, 1, 2 etc. The assignment of *dispIDs* is typically done in an *IDL* definition of the interface:

```
[uuid(1496b440-040c-11d1-baea-00a0248a38b2)]
dispinterface Example {
   properties:
      [id(0)] short val;
   methods:
      [id(1)] void Do(void);
};
```

The keystone of *Automation* is the *IDispatch* interface. *IDispatch* is an ordinary *COM vtable* interface that may be implemented by any object that wants to expose a *dispatch interface.*

```
interface IDispatch: IUnknown {
   HRESULT GetTypeInfoCount(unsigned int *pctinfo);
   HRESULT GetTypeInfo(unsigned int itinfo,LCID lcid,ITypeInfo **pptinfo);
   HRESULT GetIDsOfNames(REFIID riid,
                         OLECHAR **rgszNames,
                         unsigned int cNames,
                         LCID lcid,
                         DISPID *rgdispid);
   HRESULT Invoke(DISPID dispID,
                  REFIID riid,
                  LCID lcid,
                  unsigned short wFlags,
                  DISPPARAMS *pDispParams,
                  VARIANT *pVarResult,
                  EXCEPINFO *pExcepInfo,
                  unsigned int *puArgErr);
};
```

At the heart of the dispatch interface mechanism lies the *IDispatch::Invoke* method. The *dispatch identifier,* i.e. the *dispID*[274] argument of this method, determines which method is to be executed or which property is to be read or written, and the *wFlags* argument identifies the type of call – "property get", "property put", "property put by reference", or "method call".[275] The idea behind the term *"dispatch interface"* is that this type of interface should make it possible for its clients to *dispatch* a method call – or property access – to its implementation during run-time, which, of course, is done by the client's calling *Invoke* with the proper *dispID* in order to bring about the actual mapping between the *dispID* and the piece of code to be executed. The parameters of the call are stuffed into an array of *VARIANT* type records, being part of the *pDispParams* argument, and the result value is returned in another *VARIANT* argument, *pVarResult.* The *VARIANT* data type is very complex, but in principle is a bundle of data tagged with identifiers for each parameter type. Error

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- *Application* –- a top-level object that is used as a starting-point for further navigation and to retrieve information about the application as a whole, such as its visual appearances and its extension on the screen; there are also operations providing support for help information display, undo, and quitting the application
- *Document* – supports opening, changing, saving and printing a document
- *Documents* – if the application supports the handling of multiple documents they may be navigated through this collection
- *Font* – useful for retrieving information and manipulating founts

There is also a standard for collection objects (see [Broc95] p. 662 et seqq.).

[274] All *dispID* values below or equal to zero are reserved, and some of these have special uses. For instance, *dispID* 0 *(DISPID_VALUE)* signifies the default member of a dispinterface. For more details, please refer to [Broc95] p. 645.

[275] The corresponding constant identifiers are *DISPATCH_PROPERTYGET, DISPATCH_PROPERTYPUT, DISPATCH_PROPERTYPUTREF,* and *DISPATCH_METHOD.*

information is passed to the caller through the *pExcepInfo* and *puArgErr* parameters, and *lcid* is used to inform *Invoke* of the current locale, i.e. the national language in use.[276]

Invoke is typically implemented as a switch on the *dispID* argument, very often doing little more than forwarding calls to various *vtable* methods in other interfaces of the same object. The other three member functions of *IDispatch* are used to retrieve type information *(GetTypeInfo* and *GetTypeInfoCount)* and to retrieve the *dispIDs* that correspond to an array of method and property names given as strings *(GetIDsOfNames),* a feature referred to as *late binding.*[277] In effect, *IDispatch* makes it possible for a client such as, for example, the *Visual Basic* run-time system to discover the methods and properties of *dispinterfaces* dynamically and call their methods at run-time.[278] It is possible for one object to have multiple *dispatch interfaces,* since *dispatch interfaces* have distinct *IIDs* just like ordinary *vtable* interfaces.[279]

Significantly, the range of permissible attributes as well as argument types for a *dispinterface* differs in many respects from that of *vtable* interfaces. The types of arguments admissible in a *dispinterface* are in the main more restricted than those supported by *vtable* interfaces. The reason for this is, of course, the design bias towards *Visual Basic,* a language that does not support some *C* data types, such as structures or the unsigned variants of the basic integer types.

Although a dispatch interface brings the blessings of late binding to the world of *COM* objects and suits interpreted scripting languages well, it also implies considerable overhead, inasmuch as an additional step of indirection is introduced by having an intermediate method *IDispatch::Invoke* call another method as indicated by a *dispID* instead of calling the method directly and also because of the sometimes quite time-consuming processes of packaging and unpacking *VARIANT* records and doing type checks and type conversions at run-time. The loss in performance is most marked when *in-process* objects are handled; if a *local* or *remote server* is accessed, marshalling will have to be done anyway and the performance overhead incurred by the *dispinterface* will often dwindle to insignificance. In addition, the use of *dispatch interfaces* from *C/C++* involves much more troublesome coding for the programmer than the use of an ordinary *vtable* interface. To have the best of both worlds, it is possible to create what is known as a *dual interface* object, which exposes the very same functional-

[276] The mysterious *riid* argument is "reserved", and should always be set to *IID_NULL.* See [Broc95] p. 685.

[277] There are a number of *OLE* functions simplifying the implementation of *IDispatch* considerably. Given an *ITypeInfo* object describing the *dispinterface,* the *OLE API* function *DispInvoke* may, for example, automate the larger part of the implementation of *IDispatch::Invoke.* As a matter of fact, *DispInvoke* is a simple wrapper around *ITypeInfo::Invoke,* which will be the real workhorse if this path is taken. And another *OLE API* function *DispGetIDsOfNames,* which converts names to *dispIDs* by using type information, makes the implementation *IDispatch::GetIDsOfNames* trivial. The implementation of *DispGetIDsOfNames* itself is also very trivial, being nothing more than a simple wrapper around the method *ITypeInfo::GetIDsOfNames.* The implementation of *IDispatch* could be simplified even further, as there is an *OLE API* function *CreateStdDispatch,* by which, given an *ITypeInfo* pointer, a *standard dispatch object* can be created, implementing a kind of boiler-plate *IDispatch* that typically is taken advantage of by the real object through aggregation (see [Broc95] p. 710 et seqq.). In this case, the object will, of course, return a pointer of the *IDispatch* interface of the aggregated standard dispatch object, whenever queried for *IDispatch.* However, the use of *CreateStdDispatch* implies that the *locale* (i.e. national language) used has to be fixed, which may make it less useful than one would be inclined to believe *prima facie.*

[278] The *type information* of an object is usually stored in a *type library,* and, thus, this dynamic discovery may also be done through a *type library,* if there is one containing a description of the interface. *Type libraries* may either be generated more or less automatically by a development tool or be created by compiling handcrafted *IDL* files with the *MIDL* utility, which also creates the proxy and stub code needed for marshalling and header files with function prototypes for the interfaces declared in the file. In the early days, there was a special type definition language known as *ODL (Object Definition Language)* intended solely for the creation of type libraries, and *ODL* files were compiled by a facility called *MKTYPLIB.* However, as *ODL* was later integrated with *IDL, MKTYPLIB* was rendered obsolete. A type library may also be created at run-time through the *CreateTypeLib* function, which creates an empty type library in a file named by the caller and returns an *ICreateTypeLib* interface pointer, through which the contents of the library may be further manipulated.

To be able to read a type library, the client must first load it by calling one of the functions *LoadRegTypeLib* or *LoadTypeLib.* The first expects the *LIBID* of the library (i.e. its *GUID)* as an argument, whereas the second takes the path name of the library as its argument. Whichever of these is called, a pointer to an *ITypeLib* interface will be returned, if the call is at all successful. The member functions of this interface are too copious and complex to be described here, but make it possible to retrieve one or more pointers to the *ITypeInfo* interface. Albeit even more complicated than *ITypeLib,* it not only enables the client to retrieve all kinds of type information about the item it represents, but will also make it possible, for instance, to create an object of the *coclass* it represents, provided, of course, that it does represent a *coclass*, or to invoke the member functions of a *dispinterface.* Type information items are frequently part of complex nested structures, which may be navigated through the member functions of the *ITypeInfo* interface. There are also other ways to access type libraries, which we, however, will not discuss here. For more details, see [Broc95] p. 145 et seqq.

[279] One of these must, however, be elected the default *dispatch interface,* which will be returned when *QueryInterface* is called with the *IID* of *IDispatch* itself. A *dispatch interface* can be assigned to be the default interface through the *IDL default* attribute.

ity through both a *dispatch interface* and a *vtable* interface and thereby permits a user of the interface to choose between late and early binding. A *dual interface* is implemented by having the *vtable* interface inherit from *IDispatch,* and in the *IDL* declaration it should be marked as *dual.* The argument types will be restricted to those admissible in a *dispatch interface,* i.e. the *automation-compatible types,* which may be a drawback if the primary use of the interface is as a *vtable* interface. Nevertheless, *dual interfaces* are widely used, and whenever a *dispatch interface* is designed, there is little reason not to make it dual.

In *COM,* there is also a possibility to create *outgoing interfaces,* which enable a user of a *COM* object to register callback interfaces with the *COM* object, which will then call the methods of this interface upon the occurrence of certain events. An object that supports outgoing interfaces is referred to as a *connectable object,* exposing its outgoing interfaces through what is known as *connection points*. The connectable object implements the interface *IConnectionPointContainer* and creates one or more *connection point objects,* which each must implement the *IConnectionPoint* interface. A client's implementation of an outgoing interface is called a *sink*. The client queries the connectable object for the *IConnectionPoint* interface of the connection point it wishes to attach its sink to and then establishes a connection between the sink and the connection point by calling *IConnectionPoint::Advise* with a pointer to the interface of the sink. Hereupon, the connectable object will call the methods of the *sink* object through the connection point in order to notify the sink about various events, until the connection is broken by a call of *IConnectionPoint::Unadvise.*

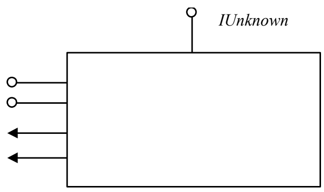

Figure 6. A connectable COM object, exposing two vtable and two outgoing interfaces (besides IUnknown).

A *COM* object is usually depicted as a box, and its interfaces are shown as plug-in jacks extending from the box. *IUnknown* is located on top of the box by convention. *Outgoing (event) interfaces* are displayed as arrows pointing out from the object. There is no special way to distinguish a *dispinterface* from a *vtable* interface in this kind of diagram.

In *.NET,* no distinction is made between *vtables, dispinterfaces,* and *outgoing interfaces,* but instead more general and considerably simpler mechanisms have been introduced to supply the same kind of functionality. Firstly, full support for reflection has been added through the *System.Reflection* class, which utilises the metadata emitted into the *DLL* and *EXE* files in addition to the *MSIL* code by *.NET* compatible compilers. Secondly, *delegates* can be used to implement events and support dynamic invocations in an easy way. A *delegate* is an object of the class *System.Delegate* or of a class derived from it, wrapping a method pointer and exposing methods, by which the method pointed to can be invoked synchronously or asynchronously. A *listener* object listening for a certain event provides a *sender* object with such a *delegate* object, which the sender then calls in order to send events to the listener or make callbacks on it. What kinds of delegates the sender supports, it makes known through metadata, which can be inspected at run-time by, for example, development environments and other tools.

1.5.1.5 Object Creation and Server Activation

COM objects intended for non-local use, sometimes referred to as *custom components,* are associated with a special *GUID* called a class identifier, or a *CLSID* for short.[280] *COM* uses the system registry of *Windows* to

[280] To be more exact, the *CLSID* specifies the top object of the custom component, which, of course, may contain any number of aggregated and contained *COM* objects or hierarchies thereof. *COM* objects intended for internal use inside a module or component do not need a *CLSID* or to support object creation through class factories as described in this section, since they can be trivially created by, for example, the *new* operator of *C++*. When instances of a class are expected to be created through a *COM* function, such as *CoCreateInstance,* that requires a *CLSID* as a parameter, a *CLSID* is on the other hand always needed. *Compound document content objects, ActiveX Controls,* and *automation objects* also always need to be assigned a *CLSID*. See [Broc95] p. 73.

map *CLSIDs* to, for example, the binaries that implement a certain class, the binaries of proxies and stubs needed for marshalling, type information libraries, and *programmatic identifiers* (also known as *ProgIDs)*[281], a form of text strings used as human-readable identifiers of classes in some programming environments, such as *Visual Basic*. Custom components are implemented by *servers,* which contain the code and data of one or more such objects and may be *in-process, local,* or *remote,* as will be explained below.

In *COM,* custom components (i.e. *COM* objects with a *CLSID)* are created through class factories. This may happen indirectly, through *CoCreateInstance,* the *COM* counterpart of the *new* operator of *C++* and *Java,* or by direct requests to the specific server *IClassFactory* (or *IClassFactory2*[282]*)* interface, which supports the creation of the class of *COM* objects in question. A *COM* object implementing one of the class factory interfaces is referred to as a *class object,* and there should be a separate class object for each *COM* class supported in a server. The *IClassFactory* is not very complicated, exposing only two methods:

```
interface IClassFactory: IUnknown {
   HRESULT CreateInstance(IUnknown *pUnkOuter,REFIID riid,void **ppv);
   HRESULT LockServer(BOOL fLock);
};
```

The *CreateInstance* method is used to create a single object of the class supported. If the object will be part of an aggregation, the aggregating object – its *outer unknown* – must be specified as *pUnkOuter*. The *riid* parameter is used to select which interface pointer should be returned as *ppv*. The *LockServer* method is used to increment or decrement the *lock count* of the class factory, which controls the lifetime of a class object and its server. To be able to make creation requests through the class factory interface of the class object, the client will, of course, first need a pointer to this interface. Such a pointer can be retrieved through the *COM* library function *CoGetClassObject*.

However, the programmer does not need to think about class objects and factories at all, if he instead uses *CoCreateInstance,* which hides all the nitty-gritty details of factory access. In particular, *CoCreateInstance* is frequently used when only a single instance of a class is to be created:[283]

```
CoCreateInstance(REFCLSID rclsid,       // CLSID of object to be created
                 IUnknown *pUnkOuter,   // pointer to outer unknown or NULL
                 DWORD dwClsContext,    // execution context
                 REFIID riid,           // interface pointer to be returned
                 void **ppv);           // interface pointer returned
```

This function is really only a nifty wrapper, which retrieves a pointer to a class factory and uses it to create a single instance of the class handled:

```
CoGetClassObject(rclsid,dwClsContext,NULL,IID_IClassFactory,&pCF);
hresult=pCF->CreateInstance(pUnkOuter,riid,ppvObj);
pCF->Release();
```

When *CoCreateInstance* is used together with a remote server, the code has been optimised, so only one cross-network access is made.

The *servers,* in which custom components are implemented, come in a number of flavours or *server types:*

- *in-process servers* are implemented as *dynamic link libraries (DLLs)* executing in the same process as the client

[281] The functions *ProgIDFromCLSID* and *CLSIDFromProgID* may be used for conversions between these two types of identifiers.

[282] *IClassFactory2* extends the *IClassFactory* interface by support for licensing.

[283] [Broc95] p. enumerates the cases when the more complex *CoGetClassObject* method must be used, viz. when:

- more than one object of the same class is to be created
- another interface than *IFactory* is needed, typically *IFactory2*
- a call of *IFactory::LockServer* will be done

- *local servers* are implemented as separately executing processes on the same machine as the client, communicating with the client process through *LRPC (Lightweight Remote Procedure Call)*

- *remote servers* are implemented as *DLLs* or separate processes executing on a different machine from that of the client process, taking advantage of the facilities of *DCOM (Distributed Component Object Model),* which, in turn, uses *RPC (Remote Procedure Call)* as a low-level communication protocol

- *in-process handlers* (or *object handlers)* are partial *DLL*-based object implementations, which may take care of, for instance, performance-critical members or interfaces that must be implemented in-process[284], whereas the remaining members and interfaces are delegated to a local or remote server, usually through a standard proxy[285]

The three possible ways of running a server – *in-process, locally,* or *remotely* – are referred to as *execution contexts.* One may expect that the *in-process handler,* which is a partial implementation only, must be combined with a local or remote server, but this is not always the case, since, at times, a limited version of an object may be exactly what is desired. The handler version may, for example, be freely redistributed, whereas the full version may be restricted to registered licensees only.

Before discussing how object initialisation will happen for the different server types, we must shortly consider how *remoting* is done in *COM.*[286] A fundamental objective of any object request broker technology, such as *DCOM,* is to bring about transparent *remoting* of the interfaces of an object or component. This is commonly done by introducing into the client a *proxy* object that emulates the interfaces of the remote object, which may then in fact execute on a different machine, perhaps even in a different part of the world. A client of a *COM* object always uses interface pointers to access the object. If the object is implemented in an in-process server on the same machine, the interface pointer will point to an interface on the real object. If, the object is implemented by a local or remote server, the pointer will, however, instead point to interfaces on a *proxy* object in the same process as the caller.

The *proxy* emulates the real object by exposing its interfaces, thereby effecting the *local/remote transparency* that is its very purpose. The implementation of these interfaces in the proxy is, however, very simplistic: The proxy packages, or *marshals,* the parameter data and sends off the package to a *stub* in a local or remote server. The *stub* unpacks, or *unmarshals,* the data and calls the proper method in the server object with the unmarshalled arguments. The *stub* then marshals the return value and sends it back to the *proxy,* which, in turn, unmarshals it and returns it to the client. To the client, it is entirely transparent whether the object is executing in-process or in a local or remote server, except that the execution times will differ appreciably, of course.

In *COM,* proxies and stubs for (almost) all standard, predefined *COM* and *OLE* interfaces are supplied as part of the *OLE DLLs.* If the developer defines his own interfaces, often alluded to as *custom interfaces,* the code implementing proxies and stubs for these may be generated conveniently from *IDL* declarations by running *Microsoft's MIDL.EXE* tool.[287] Marshalling done by *MIDL* generated code is referred to as *standard marshalling.*[288] The proxy and stub objects used in standard marshalling are really only containers or managers

[284] The reason why a member function must be implemented *in-process* may be that it has arguments that cannot be shared across process boundaries (such as handles to device contexts) or that it lacks marshalling support.

[285] Object handlers are used extensively in *OLE* compound document handling. Cf. [Micr94] p. 16 et seqq.

[286] I will not here consider the support for asynchronous calls introduced in *COM* with the release of *Windows 2000.* See [Micr02b].

[287] Additionally, *MIDL* creates files containing function prototypes for the interface methods and a named constant for the interface *IID.* The generated code will be in the programming language *C.* Type libraries are also created with *MIDL.*

[288] One general problem with marshalling as implemented in *COM* is that custom interface marshallers for each object that exposes a custom interface must be installed on every machine that will potentially use this object in order to make it possible to create the proxies, when this actually happens. This also implies that in a distributed environment, it will be difficult to support run-time discovery of new remote objects and interfaces. By using type information stored in type libraries, it would be possible for a client programme to do *dynamic marshalling,* i.e. build and execute the marshalling code during run-time. To implement support for this is, however, certainly no trivial task. [Broc95] p. 297 mentions some plans to include support for dynamic creation of facelets and stublets from *IDL* scripts in future versions of *COM.* On how these issues are addressed in *.NET,* see [OH01].

for *interface marshallers,* i.e. snippets of code that know how to marshal the method arguments of a certain interface. This is the reason why proxies and stubs are often referred to in *COM* as *proxy* and *stub managers,* respectively. Each interface marshaller consists of an *interface proxy* or *facelet* in the proxy object and an *interface stub* or *stublet* in the stub object. Each facelet communicates with its corresponding stublet individually via the *RPC channel object* in the *COM Library.*[289]

There is also an option to provide *custom marshalling* by implementing the *IMarshal* interface on an object and writing one's own proxy for the object, which can, for example, be done in order to improve performance.[290] In any case, custom marshalling uses the same basic architecture as standard marshalling.[291] But let us now return to the issue of object initialisation.

When a *COM* object is about to be created, the first thing that must be done is to locate the server, which implements the object. This is done by the *Service Control Manager (SCM)*[292], which inspects the relevant entries in the *Windows* system registry to accomplish this feat. These entries map a *CLSID* to the path names of one or more servers – one server for each server type supported.[293] The system registry entries may have been created by an installation utility or by the server that implements the component itself, if the component is capable of *self-registration.*[294] It is also possible for a class to *emulate* another class by creating entries in the registry that map the emulated *CLSID* to its own *CLSID.*[295] When *SCM* has taken cognisance of the path of the server, its further actions are determined by the execution context of the server.

If the server is *in-process, SCM* simply returns its path to *COM*. The *COM Library* then loads the *DLL* by calling the *COM* function *CoLoadLibrary* and retrieves a pointer to the *DllGetClassObject* function of the in-process server:[296]

```
STDAPI DllGetClassObject(REFCLSID rclsid,REFIID riid,void **ppv);
```

This function, which every in-process server must implement, creates a class factory for the class indicated by the *rclsid* argument and then returns a pointer to the interface indicated by *riid* in the *ppv* argument. It is called by the *COM Library* so as to retrieve an interface pointer to the class factory requested, and this pointer is then returned to the client that originally called *CoGetClassObject*.

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289 A great deal of detail has been omitted here. Consult [Broc95] p. 290 et seqq. for a richer account.

290 [Broc95] p. 289 gives four examples of cases where *custom marshalling* may be appropriate, viz. to avoid proxies to proxies by short-circuiting, to avoid unnecessary *IPC* to objects that keep their entire state in shared memory or the like (e.g. storage and stream objects), to avoid unnecessary *IPC* or network traffic to objects with an immutable state by copying the state to the proxy, and to reduce *IPC* and network traffic by intelligent grouping of requests.

291 When an interface pointer is first made available by a server in, for example, *CoRegisterClassObject* or *IClassFactory::CreateInstance,* the *COM* function *CoMarshalInterface* will be called by the server code. *CoMarshalInterface* will query the object for the *IMarshal* interface, and, if this interface is at hand, it will retrieve the *CLSID* of the proxy of the object from it as well as a *marshalling packet,* i.e. a byte stream of arbitrary information understood by the proxy. If *IMarshal* is not implemented, *CoMarshalInterface* will default to *CLSID_StdMarshal* and also create a standard marshalling package – this is the way standard marshalling works. Actually, this is not altogether true: Before defaulting to the standard proxy, *CoMarshalInterface* will query the object for the *IPersist* interface and, if this is available, it will call *IPersist::GetClassID* to get the *CLSID* of an object handler, if there is one. The object handler will, however, use the standard proxy anyway. For more details, refer to [Broc95] p. 285 et seq.

COM will then transfer the *CLSID* and the marshalling package from the server process to the client process, which may happen instantly or after a period of intermediary storage in a global table. In the client code, which may be located in e.g. *CoGetClassObject* or *IClassFactory::CreateInstance,* the *COM* function *CoUnmarshalInterface* will be called to create a proxy of the class indicated by the *CLSID* received from the server side. Then *CoUnmarshalInterface* will pass the marshalling package to this proxy through the *IMarshal* interface, the implementation of which is compulsory for proxies, and finish its mission by returning an interface pointer to the proxy object.

292 Pronounced "scum".

293 Cf. [Broc95] p. 226 et seq.

294 See [Broc95] p. 228 et seq. A *DLL* server supports self-registration through the functions *DllRegisterServer* and *DllUnregisterServer,* whereas a local server will have to handle the command line arguments */RegServer* and */UnregServer.*

295 Emulation may be either *permanent* or *temporary.* A *permanent emulation* cannot be reversed – probably the server of the emulated object has been overwritten or removed –, whereas a *temporary emulation* is reversible. Emulation may, for example, be useful when a new version of a class arrives, implementing all the interfaces of an older one in addition to some new ones.

296 This is done by a call of the *Windows API* function *GetProcAddress.*

If a *local server* is referenced, *SCM* instead starts the server application, in case it is not already running. During initialisation, the local server should call *CoRegisterClassObject* for every *COM* class it supports in order to create and register the class factories for these classes.[297] When the local server has been loaded, *SCM* returns a *RPC* handle to a stub connected to the class factory. The *COM Library* finds the proxy or object handler code through the system registry, creates a proxy object, and passes it the *RPC* handle.[298] An interface pointer to the proxy is then returned to the client.

The *remote server* case does not differ very much from the local server one, except that after checking in the registry, the local *SCM* forwards the request to the *SCM* on the remote machine through *RPC*. Instead of the path of the server, the address of this remote machine is given by the registry entry.[299] *SCM* on the remote machine, in turn, retrieves the path of the server to be loaded from the system registry there and then loads the remote server, be it a *DLL* or an *EXE*. If the remote server happens to be a *DLL*, a *surrogate process* is also started, into which the *DLL* is loaded. When the *RPC* connection has been duly set up, the local proxy will receive an *RPC* handle, just as is the case with a local server, but now the proxy will, of course, be connected to the remote server.[300]

Interface negotiation introduces a certain amount of overhead, which is usually negligible if the *COM* object is executing on the same machine as its clients. If the *COM* object is remote, this may no longer be the case. In *DCOM* support has been added for a *CoCreateInstanceEx* method that will create an object and retrieve an arbitrary number of interface pointers in one step, thereby saving a number of cross-machine *QueryInterface* calls. This method may, of course, be used also when retrieving interface pointers from a local or in-process server.

In *.NET,* the architecture for object creation and server activation has been totally revised, although there remains a choice between loading an object in-process, locally or remotely. When an object is about to be created, of which the *assembly* (i.e. *DLL)* has not already been loaded into memory, *CLR* will initiate a process to locate and load it, which is much too complex to be described here.[301] The server *DLL* may be located in a *private assembly* in the same directory as the current application, or it may reside in the *global assembly cache (GAC)* of the current machine or on another machine.

In addition, *.NET* introduces the concept of *application domains*. An *application domain* is a kind of light-weight process – not to be confused with a thread – utilised by *CLR* to run many applications, each with its own application domain, in a single operating system process, thereby increasing the scalability of *.NET* significantly.[302] Although there is fault isolation between the different *application domains* and direct cross-domain

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[297] This is, in principle at least, also possible in *in-process servers,* but leads to some nasty complications. See [Broc95] p. 240 et seq. On shut-down, the *CoRegisterClassObject* calls must be mirrored by *CoRevokeClassObject* calls.

[298] The *IPC* protocol used between a proxy and a stub in a local server is *LRPC (Lightweight Remote Procedure Call),* an interprocess communication method used in the *Windows* family of operating systems. *LRPC* uses the Windows message loop to emulate *RPC,* and, consequently, *LRPC* is limited to use between processes on one and the same machine.

[299] *DCOM* supports a number of common network address formats such as *TCP/IP* domain names, *IP* addresses, *NetBIOS* names, and *Netware IPX/SPX* names.

[300] Between a proxy and a remote stub, *Object RPC (ORPC)* is used. *Object RPC* is an extended version of *Microsoft's RPC,* which in turn is based on *DCE RPC.* To proxies and stubs, which make use of the standard marshalling architecture, the nature of the transport protocol is, however, hidden behind the *RPC* channel, an object in the *COM Library*, which implements the *IRpcChannelBuffer* interface used by the standard proxies and stubs.

In *DCE RPC* as well as *ORPC,* there is support for two kinds of protocols: *CN* (or *CO),* which is used together with connection-oriented transport protocols and *DG* (or *CL),* which is intended for connectionless transports, also known as datagram protocols. *RPC* could be used with most common network protocols, such as *TCP/IP, UDP/IP, IPX, SPX,* or *NetBIOS* (over *NetBEUI* or *TCP/IP).*

To be able to make an *RPC* call, a client must have *binding* information, which will include information about the protocols to be used (e.g. *CN* and *TCP),* a network address, and, perhaps, a transport endpoint or port number that identifies a specific process on another machine. Binding is quite a complex process, which is well described in [Chap96b] p. 245 et seqq.

[301] The interested reader is referred to [Micr01e].

[302] Already in 1997, [Pfis97b] enthusiastically saluted this new feature of *.NET:* "It can be hoped that COM+ helps to overcome the unfortunate Unix process concept which has so long stood in the way of useable component software, to eventually make place for single-address space operating systems which achieve protection through safe programming languages and possibly even through innovative hardware protection schemes. Meanwhile, it will be a challenge to use the new COM+ (i.e., Java) features in a way which does not result in maintenance and administration nightmares, caused by semantic fragile base class and version management problems."

calls are not allowed, the extra security provided by running applications in different processes can be dispensed with here, since all *managed code* is verified before it is run (unless verification has been turned off by an administrator), and, thus, access of invalid memory addresses and other similar errors are not expected to happen. Inside an application domain, objects are passed by reference and primitive data by value, whereas across application domain boundaries objects can be accessed only through the *.NET Remoting* infrastructure, which is also used when accessing objects on other machines.[303] This cross-domain or cross-machine access can be done either by copying the object from one domain to another, after which the access of it will be local *(marshalling by value, MBV),* or by accessing it via a proxy and letting the method calls together with the parameters and return values travel back and forth across the application domain or machine boundary *(marshalling by reference, MBR).* Notably, *marshalling by value* requires the object accessed to be serialisable, may be unduly time-consuming, if the object is large and only a few method calls will be made, and may be problematic, if the object depends on other remote objects and resources for its proper functioning, as very often will be the case.

In addition, the *.NET* remoting mechanism supports various transport protocols, such as *TCP, HTTP,* or *SOAP,* sophisticated lease-based lifetime control of *MBR* remote objects, and three distinct models for client and server activation of *MBR* remote objects, viz. *single call objects,* which are server-activated objects servicing only one incoming request and not holding state between method calls[304], *singleton objects,* which are server-activated objects being capable of servicing many clients and holding state between method calls, and *client-activated objects (CAOs),* which work much like the classic *DCOM* remote objects described above.

It should also be noted that when developing web services intended to be hosted by *Microsoft Internet Information Server (IIS),* the *ASP.NET* technology provides a versatile alternative to the *.NET* remoting mechanism.[305] In particular, *ASP.NET* supports the new *XML*-based[306] *.NET Web Services* technology, which makes it very simple to make the methods of any *.NET* object accessible from the web. A web service of this kind typically advertises its *contract,* i.e. the methods, parameters, and protocols it supports, through a *WSDL (Web Service Description Language)* file, which can be generated automatically and the made accessible to web clients by *ASP.NET.* The exposed methods are called via messages, typically on *SOAP (Simple Object Access Protocol)* format, sent over the web via *HTTP* to a web server from client-side proxies. The source code of such a proxy may be automatically generated by development tools capable of reading the *WSDL* description of the web service, such as, for example, the *.NET Framework* utility *Wsdl.exe.*

1.5.1.6 Object State and Object Initialisation

When an object has been created in *COM,* it often needs to be initialised in one way or the other. Conceivably, the object just created should be an instantiation of the state of an object of the same class – a state that was saved earlier to some form of persistent storage.[307] The *IPersistFile, IPersistStorage,* and *IPersistStream* interfaces are commonly used for saving and loading the state of an object, and very often the first thing done with a *COM* object upon its creation (by, for example, a call of *CoCreateInstance)* is to have it initialise itself through the *Load* operation of one of the persistence interfaces.

The functions *CoGetInstanceFromFile* and *CoGetInstanceFromIStorage* have been introduced together with *DCOM* in order to make it possible to create and initialise an object in one function call, by giving a file name or a pointer to an *IStorage* as an argument, respectively. Both these functions – just like *CoCreateInstanceEx* – may return a list of interface pointers and, in addition, provide the client with the option to specify the name of the machine on which the object is to be created.

To create a *COM* object, a client needs to know the *CLSID* of the object, and to be able to initialise the object, it must locate its persistent data. To simplify matters somewhat, *monikers* may be relied upon. A *moniker* is a *COM* object supporting the *IMoniker* interface, which acts as a kind of intelligent name for a certain *COM*

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303 See [Micr01f]. For more details on *.NET Remoting*, see also [OH01], [Srin01], [OH02], and [Espo02].

304 This will, for example, be useful when scalability is important or load balancing is attempted. See below p. 579 et seqq.

305 See [Plat02] p. 127 et seqq.

306 *WSDL* and *SOAP* are both *XML (eXtensible Markup Language)* applications. On *XML,* see below p. 562 et seqq.

307 See [Broc95] p. 401 et seqq. and [Chap96b] p. 118 et seqq.

object instance and may, for example, be used to refer to any item in a document, such as a suite of cells in spreadsheet or a paragraph in a word processing document.[308] The moniker combines information about the *CLSID* of the object and the location of its persistent data. By calling the *BindToObject* method on the moniker object, it is possible to create and initialise the object referred to by the moniker in one swoop. Since *IMoniker* inherits from *IPersistStream,* it can easily be saved and retrieved from, for example, a structured storage file.

As usual, *.NET* introduces a novel, more general and tidy solution to the problem at hand. Saving and retrieving object state is now done through *serialisation,* which comes in two variants, *binary serialisation* and *XML serialisation.*[309] The former preserves types and data exactly, whereas the latter does not preserve types and comprises only public data and fields.

1.5.2 *OLE* AND *ACTIVEX*

On the basis offered by the *Component Object Model, COM, Microsoft* has built a wealth of higher-level services and facilities. Many of those originally included the brand name of *OLE* in its name, but some were later renamed. During one period in the mid-90s, *Microsoft* rapidly launched various new technologies prefixed by the name *ActiveX* (or, in some cases, just *Active)* instead, thereby indicating that the technology had something to do with *Microsoft's Internet* and *World-Wide Web* endeavours.

1.5.2.1 Prototypes and Component Categories in OLE/ActiveX

In his classical tome *Inside OLE,* Kraig Brockschmidt called the union of the supported interfaces of a *COM* object its *prototype,* viewing a class (or type) as a particular implementation of such a prototype.[310] Not much later, the concept of *component categories* was added to *COM,* essentially being synonymous to Brockschmidt's prototype notion. Many classes may offer alternative implementations of the same component category (or prototype), and instances of these classes will be polymorphic. To each such component category is coupled a special kind of *GUID* called a *CATID* or *category identifier,* which is used by a *COM* object to advertise its own capabilities (typically through the *Windows* system registry). One example of a component category is a *compound document content object* representing a foreign document type – e.g. a spreadsheet, a video film, or a bitmap picture – in a compound document. Since all *compound document content objects* expose the same set of interfaces – the prototype or component category – they may be handled in a uniform way by a *compound document container,* notwithstanding their dissimilar implementations of this prototype.

The *prototype/component category* concept is quintessential for understanding how *Microsoft's* component technology works. *OLE/ActiveX* largely consists of definitions of such interface groups, which applications and components will have to implement in order to be able to play different rôles in different *OLE/ActiveX* interactions. The very popular *ActiveX Control* components implement such a set of interfaces – the component category of the control – in order to be able to play the rôle of a control, and an *ActiveX Control container* will implement another category so as to be able to play its rôle as a control container.

1.5.2.2 The OLE/ActiveX Technologies

It will not be possible to give even a brief account of the very rich set of *OLE/ActiveX* technologies in a study of this size, so a short list of some of the most important parts together with some hints about each technology will have to do:[311]

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[308] See [Broc95] p. 431 et seqq. and [Chap96b] p. 129 et seqq.

[309] See [Micr01g].

[310] [Broc95] p. 70.

[311] Up-to-date online documentation for most of these technologies is available at http://www.msdn.microsoft.com/library. Some additional works I have consulted and found useful will be referenced in the footnotes.

- *structured storage* makes it possible to save different types of data within one *compound file* (or *docfile)* in an internal structure reminiscent of a directory tree, where *storages* correspond to directory nodes and *streams* to files[312]

- *Uniform Data Transfer (UDT)* provides a way to transfer data between applications and is used to implement clipboard and drag and drop functionality[313]

- *property sheets* make it possible for a user to inspect and configure an object through a simple *GUI* based on dialogue boxes, which, in turn, are made up of *property pages*[314]

- *Automation* (formerly *OLE Automation)* makes it possible for an object – referred to as an *ActiveX object* – to expose late-bound *dispatch interfaces* and type information to be used from *ActiveX clients,* for example scripting environments such as *Visual Basic*[315]

- *OLE compound documents* (also referred to as *OLE Documents* or simply as *OLE)* include the core technologies of *Microsoft's* compound document architecture, supporting features such as linking and embedding and in-place activation[316]

- *OLE DB* is a technology for accessing databases through *OLE* objects[317]

- *OLE Transactions* is an *OLE*-based transaction service

- *ActiveX Controls* (formerly *OLE Controls* or *OCXs)* are visual programme components, which may be used from *control containers* such as *Visual Basic* and various other programming and *RAD (Rapid Application Development)* tools or from web browsers such as *Internet Explorer*[318]

- *ActiveX Designers* are *ActiveX* components (e.g. representing forms) implementing a visual *designer,* which provides an interface for interactive end-user customisation of a component

- *Active Documents* extends the *OLE* compound document architecture in order to make it possible for a server to control the container application more fully than is the case when plain embedding and in-place activation are taken advantage of – a facility, which enables, for example, *Internet Explorer* to use *Word* or *Excel* to display documents downloaded or locally stored in the native formats of these applications

- *ActiveX Scripting* (formerly *OLE Scripting)* enables applications such as *HTML* viewers to support scripting in languages such as *JavaScript* or *VBScript* and scripts to interact with *ActiveX Controls*

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[312] See [Isem00a] vol. 5 p. 219 et seqq., [Broc95] p. 341 et seqq., and [Chap96b] p. 107 et seqq.

[313] See [Broc95] p. 493 et seqq. and [Chap96b] p. 155 et seqq.

[314] See [Broc95] p. 761 et seqq.

[315] See [Isem00a] vol. 4, [Micr96a], [Broc95] p. 635 et seqq., and [Chap96b] p. 85 et seqq.

[316] See [Broc95] p. 811 et seqq. and [Chap96b] p. 169 et seqq. See also p. 52 above.

[317] See [Micr98i] (version 2.0) and [Micr97s] (version 1.1).

[318] See [Isem00a] vol. 5 p. 35 et seqq., [Denn97], [Chap96b] p. 265 et seqq., and [Broc95] p. 1101 et seqq. In the mid-90s, *Microsoft* introduced the epithet *Active* for many of its web-related technologies. For one thing, *Active Platform* was used as an umbrella term for *Microsoft's* entire platform for *Internet* development, consisting of the *Active Client, Active Server* and *ActiveX,* each, in turn, including a plethora of technological building blocks. *Active Client,* essentially being the *Active Platform* part of *Internet Explorer,* included support for *HTML, Java,* scripting, and access to local and remote components through *ActiveX* and was, at least partly, made available also for non-*Windows* platforms, such as *Macintosh* and *UNIX.* By the same token, *Active Server* was an umbrella term for *Microsoft's* server-side web technologies, including various parts of the *Windows NT* operating system, *Microsoft's* web server *Internet Information Server (IIS),* and the *Microsoft Transaction Server* as well as various *Microsoft* technologies providing support for directory and security services, database access, and remote object access. See [Brew97], [Winn97a], [Vaugh97], and [PM97] p. 58 et seq. See also below p. 540.

- *Active Desktop* was *Microsoft's* name for the web-enabled shell and user interface introduced in *Windows 98* and *Windows NT*[319], supporting the embedding into the desktop of various *HTML* items (e.g. hyperlinks, *HTML* documents, images, *Java* applets, and *ActiveX Controls)* as well as the *Active Channel* technology for *webcasting*

- *Active Server Pages (ASPs)* are used for running scripts written in script languages such as *JScript* or *VBScript* on web servers and for including such scripts in *HTML* pages[320]

- *ActiveX Data Objects (ADOs)* provide a way – built on top of *OLE DB* – to interface databases from applications and web pages – typically in a script on an *ASP* page – featuring amongst other things support for transparent client-side caching through the *Remote Data Service (RDS,* previously known as the *Advanced Data Connector, ADC)*[321]

- *Microsoft Transaction Server (MTS,* originally code-named *Viper)* is *Microsoft's* transaction processing monitor, largely built on the *OLE Transactions* technology and now wholly integrated with *COM* through *COM+,* which, thus, also comprises the latest version of *MTS*[322]

- *Microsoft Message Queue Server (MSMQ,* originally code-named *Falcon),* is *Microsoft's* variant of *message-oriented middleware (MOM),* supporting connectionless messaging between distributed applications; the *queued components* feature of *COM+* is a component-based abstraction layer built on top of *MSMQ*[323]

- *Microsoft Repository,* an *Active X*-based product co-developed by *Texas Instruments* and *Microsoft,* provides a store where various pieces of meta-information can be accumulated by programming and modelling tools in order to support development and reuse of components and applications

- *Active Directory* is the *Windows* directory service, the interface of which may be accessed through *ADSI (Active Directory Services Interface* – the predecessor was known as *OLE Directory Services)*[324]

- *Collaboration Data Objects* (previously *OLE Messaging* or *Active Messaging)* is an *Automation* object interface to *Microsoft's* e-mail infrastructure *MAPI (Messaging Application Programming Interface)*

- *Web Browsing* encompasses *WebBrowser,* an *ActiveX* control that may be included in any application to provide it with browsing facilities, and *WebBrowserApp,* an *ActiveX* object that is used to control *Internet Explorer* from external applications

- *Internet Client Component Library* includes *ActiveX* components for video, chatting, conferencing, multimedia net shows, tables, agents (capable of animation and speech)[325], and database connectivity, all intended for use in Internet applications

- *Task Scheduler* provides an *OLE* interface for automating tasks remotely or locally

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319 This *GUI* was first made available as a part of *Internet Explorer 4.0,* a web browser entirely built from *ActiveX* components. *Apple's OpenDoc*-based *Cyberdog* had a similar design. Cf. [OH97b] p. 619 and p. 622.

320 See [ADFG+00], [BBBD00], [ABCD+99], [Kirt99] p. 95 et seqq., and [Chap00] p. 369 et seqq.

321 See [Suss00], [SH98], [Kirt99] p. 53 et seqq., and [Chap00] p. 205 et seqq.

322 See [HS98b], [Plat99], [Kirt99] p. 67 et seqq., [Sess00b] p. 135 et seqq., and [Chap00] p. 239 et seqq.

323 See [Dick98], [HS98b], [Sess00b] p. 148 et seqq., and [Chap00] p. 329 et seqq.

324 See [Isem00b], [Chap00] p. 33 et seqq., and [Hahn98].

325 See [Micr98x].

Some of the above technologies – as well as others not mentioned here – will be discussed in the section on networked components, where *Microsoft's* component-based client/server technologies will be dealt with at considerable length.[326] However, most of these will probably grow obsolete over time with the introduction of new *.NET* technologies. Indeed, a few *.NET* technologies expected to supplant some of the aforementioned *COM/OLE/ActiveX* technologies have already seen daylight, most notably the *.NET* successors of *ADO* and *ASP, ADO.NET*[327] and *ASP.NET*[328]*,* and the new *Windows Forms*[329] technology facilitating the writing of forms-based applications, where *.NET objects, components,* and *controls* can be used in much the same versatile way as *ActiveX Controls* and *objects* in the previous generation of *COM*-based *RAD* tools.

1.5.3 FROM *VBX* TO *.NET*

One often hears it said that *Microsoft* is not a very innovative company, but rather tends to "embrace and extend" new technologies and trends, as they start to look promising and lucrative from a business point of view. Although this is of course a rather gross simplification, from which it is not difficult to find exceptions, such as, just to name a particularly eye-catching one, the innovative use of components in *Microsoft Transaction Server,* and *Microsoft* today sports an impressive research organisation, to which many prominent and proficient computer scientists have been recruited, it must be owned that there has historically been a strong proclivity for reactivity rather than proactivity and innovative adventurousness within the company. On the other hand, *Microsoft* is always agog for upcoming trends and ideas in the market overt and is apt swiftly to adapt and transform any promising ideas into usable, "good enough", albeit not always perfect, real technology. At times, this swift resilience to market challenges has later made multiple – and occasionally also rather painful – cycles of revisions necessary.

In particular, this will have been the case with the very key to the success of the *Windows* platform, viz. *Microsoft's* component technology, of which three distinct generations can be distinguished:

- The "personal computing, *GUI*-oriented" *VBX/OLE 1* generation (1991-1994)
    - *VBX* (1991)*,* visual interface builder components for *Visual Basic* and similar *RAD* environments
    - *OLE 1* (1992), *DDE*-based compound documents
- The "client/server, component-oriented" *COM* generation (1993-?)
    - *OLE [2]* (1993), *COM*-based compound documents
    - *OCX* (1994), *COM*-based interface builder components
    - *ActiveX* (1996)*,* adaptation of *COM/OCX* to the *Internet*
    - *DCOM* (1996), distributed version of *COM*
    - *COM+* (2000), middleware components
- The *"Internet,* object-oriented" *.NET* (2002-) generation

The introduction of the latest generation of *Microsoft's* component technology, *.NET,* implies nothing less than a bold wholesale abandonment of *Microsoft's* immensely successful *COM* strategy, partly motivated by the difficulties of adapting *COM* to *Internet* programming, but also by the challenge *Sun's* entire *Java* effort presents to *Microsoft's* rôle as the market leader in systems software. Even though *Microsoft's* first response to the *Java* challenge was fully to endorse *Java* as a language that amends some of the weak spots of *C++,* but to denounce it as a "portable operating system", *Microsoft* quickly grew increasingly cold towards *Java* also as a language, due both to the rush of bad feelings provoked by the judicial litigation against *Microsoft* initiated by

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[326] See p. 535 below.

[327] See [CDFG00+] p. 337 et seqq. and [Plat02] p. 181 et seqq.

[328] See [CDFG00+] p. 197 et seqq. and [Plat02] p. 79 et seqq.

[329] See [CDFG00+] p. 273 et seqq. and [Plat02] p. 159 et seqq.

Sun and the *U.S. Department of Justice* and to the rather obvious inopportuneness of the Trojan horse *Java* to *Microsoft's* business interests. Instead, *Microsoft* embarked upon the development of the *C#* language, a similar, but somewhat different "better C++" programming language, and, more significantly, upon the painful replacement of its current component infrastructure with the new *.NET* technology. Characteristically, *Microsoft* through *.NET* "embraces and extends" the *Java* approach to software development together with its prime peculiarities, such as the virtual machine execution model, the proliferation of huge, labyrinthine object-oriented frameworks, and an object-oriented, *JavaBeans*-like component infrastructure. Technically, *Microsoft* thus also discards the two keystones, on which *COM* was built, viz. the notion of components i) as binary entities and ii) as distinct from objects by their lack of support for implementation inheritance. There is of course a flip side of such boldness, showing in various issues, such as:

- the re-introduction of the *class fragility* problems that used to haunt object-oriented programming[330]
- significantly increased *surface area* – in particular to *RAD* programmers – through the introduction of the huge object-oriented white-box frameworks of the *.NET Framework*[331]
- *reduced performance* and *increased memory requirements* due to the virtual machine, just-in time *(JIT)* compilation-based execution model and various other features of the *CLR,* such as code verification and garbage collection[332]
- limited *backwards compatibility* and obnoxious *impedance problems* in handling the *COM* technologies not (as yet) replaced by new *.NET* technologies, such as the *COM+* middleware components and the *OLE* compound documents support[333]

Although these problems are by no means insignificant, they will certainly not prevent *.NET* from becoming the major success *Microsoft* wants it to be. Certainly, it will also render the choice between the *.NET* and the *Java* infrastructures, apparently kissing cousins by design, the topic du jour amongst IT strategists and software pundits for the foreseeable future.

[330] On these *class fragility* problems, see below p. 234 et seqq.

[331] On the concept of *surface area,* see footnote 722 on p. 152. On the distinction between white-box black-box frameworks, see footnote 1280 on p. 255. Cf. also [Chap02] p. 167 et seqq. and p. 152.

[332] However, it is possible to create native binaries for a particular processor from an *MSIL* module by using a *Native Image Generator (NGEN),* thereby doing away with the need for *JIT* compilation.

[333] See [Chap02] p. 221.

1.6 THE *OBJECT MANAGEMENT GROUP* AND THE *CORBA* SPECIFICATIONS

The *Object Management Group (OMG),* was founded in 1989 by *Data General, Hewlett-Packard, Sun, Unisys, 3Com, American Airlines, Canon,* and *Philips Telecommunications.*[334] Whereas the original motives for the creation of *OMG* concerned the need for a standardised *compound document architecture,* the focus of the organisation gradually switched towards a more general infrastructure for *distributed objects,* which was also believed to be a necessary step on the avenue to compound documents. Over time, new areas have been included in its range of interests, such as notably object-oriented modelling. According to the present bylaws of *OMG,* the purpose of the organisation is rather broad:[335]

> *1.1. to promote a single object-oriented applications integration environment based on appropriate industry standards;*
>
> *1.2. to promote a framework for compatible and independent development of applications;*
>
> *1.3. to enable coordination among applications across heterogeneous networked systems in a multinational, multilingual environment;*
>
> *1.4. to adopt a core of commercially available specifications of this framework and to promote international market acceptance and use;*
>
> *1.5. to actively influence the future direction and development of these adopted specifications; and*
>
> *1.6. to foster the development of tools and applications that conform to and extend this framework and to provide a mechanism for certifying compliance with the adopted specifications.*

Today *OMG* has grown into a large and influential industrial consortium and a major player in the software standardisation business with its about 800 members – including all major computer companies –, although, strictly speaking, it does not issue any standards at all, but only "adopted" and "available specifications".

1.6.1 THE ORGANISATION AND PROCESSES OF *OMG*

In order to understand what it is *OMG* produces and why its output looks the way it does, one must understand something of its organisation and processes. *OMG* is an association of corporate members, primarily companies either in the computer business or with a strong interest in computing, but also many academic institutions and government agencies. At its top is a *Board of Directors (BOD)* and a chairman and CEO. At the formation of *OMG,* Christopher Stone of *Data General* was appointed president, a position which he retained until September 1997, when he joined *Novell* as vice president of strategy and corporate development, whereupon the former vice presidents Richard Soley and William Hoffman succeeded him at the helm of *OMG*. Today, Soley is the chairman and CEO of the organisation. Furthermore, there are different categories

[334] So [OMG01a]. [Wats96a] states that the number of founders were 11 and so does [Betz94], who in addition to the ones mentioned above also names *Digital, Hyperdesk,* and *NCR* amongst these. [Wats96a] gives some additional background information. During the mid-1980s the *New Wave* research group at *Hewlett-Packard* and the *Comprehensive Electronic Office Mark II (CMII)* or *902* group at *Data General* were both working on object-oriented document environments and what is now known as *compound document architectures*. These projects were linked together by the analyst Patricia Seybold in 1987, and researchers from *Sun* and a number of other companies soon joined the informal discussions and meetings of these two groups. As time went on, the participants of these early meetings decided to formalise their co-operative efforts by forming *OMG*.

Undoubtedly, the *Windows*-based *New Wave*-product was a major source of inspiration also for *Microsoft's* compound document architecture *OLE,* and *Microsoft* reportedly licensed its underlying technology *OMF (Object Management Facility)* from *Hewlett-Packard*. During a period, *HP* and *Sun* co-operated to create a distributed version of *OMF* known as *DOMF (Distributed Object Management Facility),* which was quite influential on the early work of *OMG*. In these early days, there were also some connections to the project at *Sun* working with the *Oak* programming language, the predecessor of *Java*. See also [Morg97] p. 2.

[335] See [OMG02c].

of membership with distinct privileges, membership fees, and voting rights. *Contributing Members* are full members and may take part and vote in all the boards, committees, and task forces of *OMG*, whereas *Domain Members, Platform Members, Influencing Members, Government Members, Auditing Members, Analyst Members,* and *University Members* all have more or less restricted voting and participation privileges.[336]

Major events in the work of *OMG* are the *OMG Technical Meetings,* where representatives of the member companies convene in order to discuss all kinds of issues and advance the specification process that is the main business of *OMG*. The entire technical specification process of *OMG* is managed by its *Technical Committee (TC).*[337] The *Technical Committee* is organised as a *Platform Technology Committee (PTC),* a *Domain Technology Committee (DTC),* and an *Architecture Board (AB)* with distinct spheres of responsibility, which will be briefly explained below. However, most of the actual specification work is done in *OMG's Task Forces (TFs).*[338] Before a task force is formed, a *Special Interest Group (SIG)* may be established as an informal forum for preparatory discussions within a certain area. When a task force has been chartered by one of the technology committees, it will issue a *Request For Information (RFI)* to get input and reactions on the requirements specification work it is about to enter upon. Having processed the replies to the *RFI*, the task force may make a roadmap of its further work. It may also establish subcommittees working on certain problems within its main area.

The task force will then start issuing *Requests for Proposals (RFPs),* which essentially play the rôle of requirements specifications. *OMG* member companies that intend to respond to an *RFP* must submit a *Letter Of Intent (LOI)* rather promptly, but are then given a fairly ample period of time before they have to hand in their submissions, and after the expiration of this time will follow another, often also rather generously extended period, when revisions of the submission may be done. The task force makes an evaluation of the different submissions, and the submitters will need this extra time to react to the comments made by the task force and revise their proposals accordingly. Consensus is expressly aimed at, and, at times, several submissions coalesce during the revision process.

After a voting process in the task force, the specification is handed over to the *Technical Committee* for approval. Additionally, there will be a fax poll where all voting members of the *Technical Committee* concerned will decide whether to pass the proposed specification further on. In addition, the *Architecture Board (AB)* continually checks the forthcoming specifications – including the *RFIs* and *RFPs* – for compliance with the *Object Management Architecture (OMA).* It also tries to ensure that existing specifications are used wherever applicable so as to avoid getting overlapping or duplicate, incompatible technologies within the larger framework of *OMG* specifications. Having run through all these mills, the specification may eventually be promulgated an "adopted specification" by the *OMG Board of Directors (BOD).*

After this follows a finalisation process managed by its own *Finalization Task Force (FTF),* which performs a first maintenance revision of the specification. After another series of votes in the different committees (i.e. the *Task Force* concerned, the *Architectural Board,* the *Technical Committee* concerned, and the *Board of Directors),* the specification will receive a release number and is promoted to an "available specification". Hereupon will often follow maintenance cycles and further committee work. Specifications that are little used or are considered obsolete may be withdrawn, which actually has happened rather frequently.

It should be noted that *OMG* only produces specifications, not standards, nor reference implementations, let alone validation test suites.[339] The *Open Group* has, however, developed a test and certification suite for the validation of *CORBA* object request brokers, and so have various other organisations and groups.[340] Additionally, *ISO (International Organization for Standardization)* has granted *OMG* the status of *Publicly Available Speci-*

[336] See [OMG01d] for more details about these privileges.

[337] On this process, see [OMG02c-d] and [OMG01b]. [OMG02h] outlines the present organisation of *OMG*.

[338] Cf. [OMG97j].

[339] Nonetheless, there is an *OMG Test & Validation SIG* (see http://testsig.omg.org).

[340] According to [TOG97a], object request brokers passing these tests receive the *X/Open* brand. The *Open Group* is an umbrella term for the *Open Software Foundation (OSF)* and the *X/Open Company* (see http://www.opengroup.org). On the various other testing suites, see *OMG's Interoperability Testing Resource Page* http://www.omg.org/interoperability_testing. There formerly also was a *WWW*-based *CORBAnet* showcase intended to demonstrate the interoperability of various *ORBs,* but its web site http://corbanet.dstc.edu.au has now been closed down.

fication (PAS) submitter, which was supposed to make for the rapid adoption of *OMG* specifications as *ISO* standards, but in reality very little has come out of this liaison.[341]

1.6.2 THE *OBJECT MANAGEMENT ARCHITECTURE*

In 1990, *OMG* presented the first version of its *Object Management Architecture (OMA),* which is a kind of roadmap for its further work, and since then *OMA* has been revised a number of times, having reached its current version 3.0 in 1995.[342]

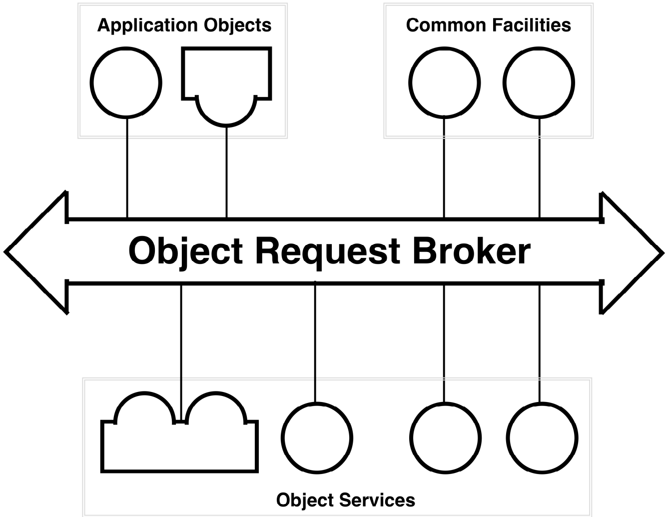

Figure 7. The OMA Reference Model

At the core of *OMA* is the *CORBA (Common Object Request Broker Architecture)* object bus.[343] The first version of *CORBA* was unveiled in 1991 and was followed by minor revisions in 1992 and 1993 *(CORBA* version 1.1 and 1.2).[344] In 1994, the next major version, *CORBA 2.0,* which filled in many of the loopholes of the earlier *CORBA* versions, was introduced.[345] Some loose ends were still left, and a *CORBA ORB Portability Enhancement* was soon adopted to fix some of the more consequential ones. New versions of *CORBA 2* were

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[341] As per October 2002, a search for *CORBA* on the *ISO* web site results in only two hits: *ISO/IEC 10728:1993/Amd 3:1996, CORBA IDL binding* and *ISO/IEC 13244:1998/Amd 1:1999 Support using Common Object Request Broker Architecture (CORBA).*

[342] [SS95]

[343] At http://www.omg.org/technology/documents/spec_catalog.htm, current versions of all specifications adopted by *OMG* are available. The literature on *CORBA* and the related *OMG* technologies is not quite as overwhelmingly large as that on *COM* or *Java.* Jon Siegel's two books [Sieg96] and [Sieg00] provide excellent introductions to *CORBA 2* and *CORBA 3* respectively and are by many considered the best general treatments of the technology. Some other highly regarded *CORBA* authors are Thomas Mowbray, who co-authored [MZ95], [MR97], and the *CORBA* design patterns book [MM97], and Alan Pope, the author of [Pope98]. As per October 2002, only a few books, including the early bird [Hoqu98], the aforementioned [Sieg00], and [Bolt01], have as yet made a claim to cover *CORBA* 3, the most recent instantiation of the technology, which was finally ratified only in July 2002 (see [OMG02a]). Some other more or less useful *CORBA* books are [BenN95], [OPR96], [OHE97], and [Bale00]. On web programming with *CORBA,* see [BenN98], [BenN97], [HS98c], and [Zaha00], of which the latter, just like [SGR99], also provides an "enterprise" perspective on *CORBA.* On *Java* programming with *CORBA,* see [OH98] ([OH97b] is the first edition of this book), [BVD01] ([VD97] and [VD98] are earlier editions of this book), and [LBS98]; on *C++* programming with *Java,* see [VVBV99] and [HV99]; on *CORBA* programming with *IONA's Orbix ORB,* see [Bake97b]; on *COM/CORBA* integration, see [RC98]. A book-length comparison of *CORBA* and *COM* is provided by [Prit99]. More literature suggestions are offered at *OMG's* "reading room", http://www.omg.org/technology/readingroom.htm.

[344] See [OMG02e] on the different versions of *CORBA.*

[345] See [OMG96a].

then introduced from time to time, starting with *CORBA 2.1* released in 1997 and ending with *CORBA* 2.6 in late 2001. Finally, the long awaited *CORBA 3.0* was adopted in July 2002, featuring *inter alia* the *CORBA Component Model (CCM).*[346]

Around the *CORBA* "object bus" a number of basic services known as the *CORBA Object Services (COSS),* or simply *CORBAservices,* has been defined, providing basic functionality for *objects*. *CORBA Common Facilities* or *CORBAfacilities,* in contrast to *CORBAservices*, are intended to provide more complex services – such as, for instance, compound document handling, mobile agents support, or workflow management – intended to serve not individual objects, but higher-level constructs, such as *applications* or *documents*. A distinction is made between *horizontal facilities,* which are general in scope and should be useful within all kinds of domains, and *vertical facilities,* which will be of interest only to a certain application domain, such as manufacturing or telecommunications.

As mentioned above, the *Technical Committee* has divided its work between a *Platform Technology Committee (PTC)* and a *Domain Technology Committee (DTC).*[347] The platform technologies encompass the *CORBA ORB,* the *CORBAservices,* the "horizontal" *CORBAfacilities,* as well as the *Analysis and Design Platform.* In the mid-90s there were three task forces corresponding to these technology fields, viz. the *ORB/Object Service Platform Task Force (ORBOS PTF),* the *Common Facilities Platform Task Force (CF PTF),* and the *Object Analysis and Design Platform Task Force, (OA&D PTF).* In 1997, all *common facilities* then in process – i.e. in the *RFI* or *RFP* stage – were moved from the *Common Facilities Platform Task Force* to the other task forces, and the *CF PTF* was closed down.[348] Lately, the *ORBOS PTF* has been renamed the *Middleware and Related Services (MARS) PTF* and the *OA&D PTF* is now called the *Analysis and Design Platform Task Force (AD PTF* or just *ADTF).* In addition, a *Real-Time, Embedded, and Specialized Systems Platform Task Force (RTESS PTF)* has been established. Only few technologies are still referred to as *facilities,* although indeed the division line between services and facilities has never been altogether distinct.

Under the aegis of the *Analysis and Design PTF, OMG* has adopted the specifications for the *Unified Modeling Language (UML),* the well-known analysis and design notation, which put an end to the babel of tongues in object-oriented modelling, and the supplementary *Meta-Object Facility (MOF),* which primarily aims at the creation of a common "meta model" for the representation of *UML* models in analysis and design tools so as to facilitate interoperability between these tools. As another building block of this compages, the *XMI (XML Metadata Interchange)* specification supports the exchange of *UML* models and *MOF* meta-models between *MOF*-compliant tools. *OMG* has also issued a number of other modelling specifications, such as the *Common Warehouse Metamodel (CWM)* and the *Model-Driven Architecture (MDA),* but none of these will further concern us here.

The *domain technologies* define domain-specific ("vertical") interfaces for domains, such as manufacturing *(CORBAmanufacturing),* telecommunications *(CORBAtel),* financial services *(CORBAfinancials),* healthcare *(CORBAmed),* business integration and electronic commerce, and transportation, and all of these domains as well as some others have their own *domain task force (DTF).*[349] The domain task forces tend to come and go somewhat more frequently than the platform task forces. For example, much interest and great expectations were for a number of years attached to the work of the task force known as the *BODTF (Business Object Domain Task Force),* which worked on a standard for *business objects,* i.e. high-level, large-grained components representing domain concepts and being capable of mutual co-operation through some mechanism of loose coupling. This task force was also responsible for the development of *OMG's Workflow Management Facility* and various

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346 [OMG02a-b]. See also [Sieg02].

347 See [OMG02h].

348 However, the *Internationalization and Time Facilities* a little later became an adopted specification as the *Internationalization and Time Service,* but somehow retained its status of facility. Since then, the *Mobile Agent Facility* has also received the status of a horizontal facility (see http://www.omg.org/technology/documents/corbafacilities_spec_catalog.htm). There are also various *prima facie* "horizontal" facilities, such as the *Workflow Facility,* that for one reason or other have been relegated to the realm of domain technology.

349 As per October 2002, the following domain task forces were active: *Business Enterprise Integration DTF, Command, Control, Computers, Communications and Intelligence (C4I) DTF, Finance DTF, Geospatial and Imagery Value Added Services DTF, Healthcare DTF, Life Sciences Research DTF, Manufacturing Technology and Industrial Systems DTF, Space DTF, Telecommunications DTF,* and *Transportation DTF.*

other specifications.[350] Today, *BODTF* is no longer active, although its special area of interest is partly covered by the new *Business Enterprise Integration DTF.*

Finally, any objects that lie outside the realms covered by the specification efforts of *OMG* are called *application objects* in *OMG* parlance. Those objects are the users of the *OMA* infrastructure, themselves being specific to a certain application or component.

1.6.3 *CORBA* BASICS

The basis of the *OMG* infrastructure is *CORBA,* the *Common Object Request Broker Architecture,* which recently has appeared in a considerably updated version 3.0. The approach of *CORBA* is not binary like the *vtables* of *COM,* but is based on the *CORBA IDL (Interface Definition Language)* and mappings from *CORBA IDL* to specific programming languages. There are currently language mappings authorised by *OMG* from *CORBA IDL* to *C, C++, Ada, Java, Smalltalk, COBOL, Lisp, PL/1, Python, XML,* and the *CORBA Scripting Language.*

A piece of *CORBA IDL* code may look like this:

```
module AModule {
   exception out_of_range { string ErrorMessage; };
   interface AMessyInterface {
      attribute long ANumber;
      boolean IsTrue(in string AMessage, inout float Real, out long Number);
      void Do(in long Number,in any Something) raises(out_of_range);
   };
   interface AnotherMessyInterface:AMessyInterface {
      void DoSomethingElse();
      oneway void Send(in string AMessage);
   };
};
```

This simple example illustrates a number of important features of *CORBA IDL,* viz. that

- interfaces are grouped into modules
- each interface may contain an arbitrary number of operations and attributes
- arguments to operations are prefixed with one of the self-explanatory parameter attributes *in, inout,* or *out*
- the *IDL* language is strongly typed
- strong typing may be circumvented by using the *any* type
- exceptions may be declared and raised
- *CORBA IDL* also supports asynchronous calls through the *oneway* keyword

From the example may also be gathered that *CORBA* supports interface inheritance – actually it even supports multiple interface inheritance. In *CORBA,* in contrast to *COM,* an object has one and only one interface, but since multiple interface inheritance is supported, a *CORBA* object may combine multiple interfaces into a single one. A *CORBA* object instance is identified by an *object reference,* which, having been converted into a string, may be saved to a file and retrieved on a later occasion. In *CORBA 2.3* support was added for passing objects by value, a feature needed to achieve full compatibility with the *Java* language.

The *IDL* declarations will have to be run through an *IDL* compiler, which converts the *IDL* code into source code in the programming language targeted by the compiler and creates two pieces of code known as a *stub* and a *skeleton*. *Stub* and *skeleton* are the *CORBA* designations for the client-side and server-side proxies responsible for the remoting of interfaces, marshalling and unmarshalling, etc. These *stub* and *skeleton* files must

[350] See p. 177 et seqq. below.

be compiled and linked with the client and server implementations. In some implementations, the *IDL* compiler will generate other files as well, such as, for example, a "skeleton" implementation of the objects declared in the *IDL* file in order to help the programmer to get started with the implementation.

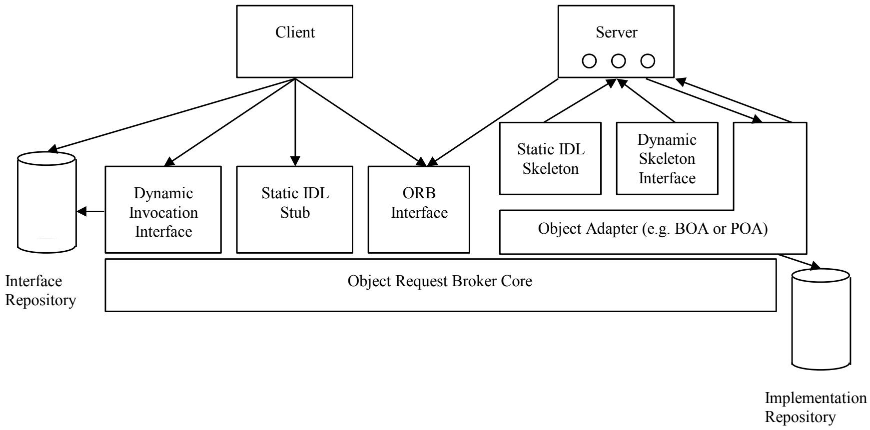

Figure 8. The structure of the CORBA object bus

When a client passes a request to the *ORB* via a static *IDL* stub, it is said to use the *Static Invocation Interface (SII).* As can be inferred from *Figure 8,* there is in *CORBA* also a *Dynamic Invocation Interface (DII),* providing support for *dynamic invocations* of the operations of an interface. To be able to build requests dynamically, the client needs type information about the interfaces that it wants to use. Such information may be retrieved at run-time from the *interface repository*. In *CORBA 2,* dynamic invocations could be either *synchronous* (blocking), *asynchronous* (non-blocking without return result), or *deferred-synchronous* (non-blocking with a return result), whereas the *deferred-synchronous* mode was lacking from static invocations. In *CORBA 3,* this has all been fundamentally revised and even the terminology has been changed.[351] Firstly, both static and dynamic invocations now support all available *interoperability modes*. The basic distinction is now made between *synchronous* and *asynchronous calls*. There are now two kinds of *synchronous* calls, *normal* and *oneway,* corresponding to the old *synchronous* and *asynchronous modes*. In addition, there are two varieties of *asynchronous* calls, *callback* and *polling*. If *callback* is opted for, the target will call a *reply handler* when it is ready, whereas the *polling* model compels the client to check intermittently for the arrival of the return value.

At the core of the *CORBA* object bus is, of course, a *CORBA*-compliant *object request broker,* that transparently performs all the magic of connecting clients and servers and distributing requests to their addressees. The *ORB* has its own interface that may be accessed by clients and servers alike, for example in order to perform initialisation of the *ORB* or to get initial references to crucial services such as the *name service* and the *interface repository*.

CORBA specifies what is known as an *adapter broker,* implying that an *object adapter* is introduced on the server side between the broker and the implementation of the remote objects. Different types of adapters can be used to support different types of storage. In a system where a large number of small objects is used, it may, for example, be advantageous to store these objects in an object-oriented database, and to do so a specialised *object-oriented database adapter* may be taken advantage of. Moreover, to make it possible to have clients and server implementations execute within a single process, when the server objects are available locally, a *library object adapter* may be used. Some types of object adapters register the classes they support as well as any instances of these in an *implementation repository,* where various other pieces of information may be stored as well, such as trace information, audit trails, and sundry administrative data. In the early days, the *CORBA* specification required all implementations to support at least one type of object adapter, the *Basic Ob-*

[351] See [Sieg00] p. 169 et seqq.

ject Adapter (BOA), which was part of the *CORBA* specification from version *1.1* to version *2.1*. Because of a number of portability problems haunting the implementations of the *BOA*, the *BOA* specification was in *CORBA 2.2* replaced with a specification of a new adapter branded the *Portable Object Adapter (POA).*[352] Today, the *POA* has ousted the *BOA* completely.

The *Dynamic Skeleton Interface (DSI)* makes it possible for object implementations to support run-time binding to their operations when a static skeleton is not available. Thus, *DSI* is often said to do for servers approximately the same as the *Dynamic Invocation Interface* does for clients. Support for *DSI* is not automatic, but the object implementation will have to provide support for what is known as the *Dynamic Implementation Routine (DIR).* The primary use of *DSI* is in inter-ORB bridges, but it may be used for other purposes as well, such as the implementation of scripting interpreters, development and debugging tools and the like.

Object request brokers implementing early releases of the *CORBA* specification such as version 1.1 would not interoperate with other *CORBA*-compliant object request brokers. To bring about interoperability, *CORBA 2.0* required all *CORBA*-compliant *ORBs* to support the *Internet Inter-ORB Protocol (IIOP),* which is a protocol used for inter-*ORB* communication over a *TCP/IP* network. Provisions have also been made for the creation of bridges between *ORBs* and gateways to non-*CORBA ORBs,* such as *Microsoft's COM/DCOM* and *Java RMI.* There are also customised versions of *CORBA* for fault-tolerant operation, for real-time systems, where support for multithreading, priorities and kindred functionality has been added *(Real-Time CORBA),* and for minimal – typically embedded or card-format – systems, where, for example, the *Dynamic Invocation Interface* and *Interface Repository* are dispensed with *(Minimum CORBA).*

1.6.4 CORBASERVICES

CORBA Object Services (COSS or *COS),* also known as *CORBAservices,* is a set of specifications providing basic functionality for *objects.*[353] To date, the services listed below have been adopted*:*

- the *Life Cycle Service* includes support for creating, moving, copying, and deleting objects
- the *Naming Service* allows the binding of names to objects and the management and navigation of name spaces
- the *Trading Object Service* is, as it were, the yellow pages of distributed objects, enabling a client to search for different types of services, which may be provided by a number of competing suppliers – such *traders* are often believed to become important elements in a future *Internet*-based *object bazaar*[354]
- the *Externalization Service* allows object state to be transformed, *externalized,* into a stream, from which it may be reinstated, or *internalized,* at a later time
- the *Property Service* makes it possible to associate named properties with an object dynamically at run-time and to set and get the values of these properties
- the *Collection Service* provides uniform access to the most common types of collections such as queues, stacks, lists, arrays, sets, etc.
- the *Relationship Service* facilitates both the assignment of *roles* to objects and the creation of *relationships* between objects
- the *Event Service* specifies an *event channel,* where suppliers and consumers may exchange events, choosing between push or pull models as appropriate, and is supplemented in various respects by the *Notification Service* and the *Management of Event Domains* specification

352 Cf. [OHE97] p. 262 et seqq.

353 These specifications are available at http://www.omg.org/technology/documents/corbaservices_spec_catalog.htm, *OMG's CORBA-services* web page. See also [Sieg00] p. 261 et seqq. Occasionally, the names of the different services have changed a little over time. For one thing, the prefix "object" has lately been removed from some services, such as the *Object Transaction Service, Object Query Service, Object Security Service,* and *Object Collection Service.* Below, I have adopted the designations used on the *CORBAservices* web page.

354 The objective of the *XML*-based *UDDI (Universal Description, Discovery, and Integration) Business Registry* is quite similar. See http://www.uddi.org. Cf. also [Beri01].

- the *Persistent State Service (PSS),* replacing the little used *Persistent Object Service (POS),* specifies how to make an object persistent, using a range of different storage types, including relational databases, object databases, and flat files
- the *Query Service* enables clients to search for objects using either of the two query languages *SQL-92 Query* (a subset of *SQL-92)* or *OQL-93*
- the *Transaction Service* (previously known as the *object transaction service, OTS)* supports transactional object interactions according to a two-phase commit scheme and is supplemented by the *Additional Structuring Mechanisms for the OTS* specification
- the *Concurrency Service* provides a facility for placing locks on resources
- the *Licensing Service* supports license metering of distributed objects and components
- the *Security Service* supports various security features, such as authorisation, authentication and audit trails
- the *Time Service* caters for synchronisation of clocks and the like and is supplemented by the *Enhanced View of Time* specification
- the *Telecoms Log Service* supports logging of events and querying of log records

In addition to the above services, there are also various domain-specific services, which will not concern us here. Most of the above *CORBAservices* specifications were put together during 1993-96, and there are currently no new general-purpose services in the pipeline, although some services may either be in the process of being revised or have already gone through one or more revisions.

1.6.5 CORBAFACILITIES

In contrast to the *CORBA Object Services,* the *CORBA Common Facilities* or *CORBAfacilities* provide services intended for higher-level constructs than individual objects, such as *applications* or *documents.* The plans made up for the facilities were very ambitious in the mid-90s, when *OMG* for a short time played the rôle of a serious challenger to *Microsoft* in the "object wars", but were later considerably scaled down. At that time, a very ambitious road-map for the *Common Facilities Architecture* was put together[355] and five *RFPs* were scheduled for processing in 1994-97:[356] *1) Compound Presentation and Interchange, 2) Time Operations, Internationalization, 3) Data Interchange, Automation, 4) Scripting, Agent Facility, Rule Management,* and *5) Information Exchange.* Currently, however, only two "horizontal" (i.e. cross-domain) facilities are listed on the *CORBAfacilities* web page:[357]

- the *Internationalization and Time* specification, which provides support for the localisation of date, time, and number data.
- the *Mobile Agents Facility,* which facilitates interoperability between different agent systems

A few other common facilities, which were adopted by *OMG* in the mid-90s, have now been deprecated, including

- the *Systems Management Facility,* also known as *XCMF,* which was not a technology developed within *OMG* in the first place, but an already existing *X/Open* standard based on *Tivoli's TME (Tivoli Management Environment)* product adopted also by *OMG*
- the *Compound Presentation and Interchange Facility,* better known as the *OpenDoc* compound document architecture, which will be briefly discussed in the next session
- the *Printing Facility*

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[355] [OMG95a]. This document was deprecated in 1999.

[356] See [Sieg96] p. 250 et seqq.

[357] See http://www.omg.org/technology/documents/corbafacilities_spec_catalog.htm. See also [Sieg00] p. 41 et seq. and p. 339 et seqq.

However, there also exist some additional facilities, which are not listed under the *CORBAfacilities* heading, such as most notably the *Meta-Object Facility (MOF),* which belongs to the modelling specifications, and the *Workflow Management Facility (WMF),* which is classified as a “domain specification”.[358]

1.6.5.1 OpenDoc

In March 1996, *OMG* adopted *OpenDoc* from *Component Integration Laboratories (CIL)* as its *compound document architecture* or, in *OMG* lingo, *Compound Presentation and Interchange Facility* (at times also referred to as the *Distributed Document Component Facility, DDCF).*[359] *OpenDoc* was developed and controlled, at least formally, by *CIL* during the years 1993-97, and its main architect was *Kurt Piersol* from *Apple.*[360] Although *CIL* could boast of more than 2000 members in 1996, it was in reality little more than a front for a small number of companies, which did the real development work. Of these, *IBM* and *Apple* were the most important ones, although, initially, *Novell* was also rather involved in the effort. In the beginning of 1997, *IBM* and *Apple* decided to close down *CIL*, and *OpenDoc* was placed in the public domain.[361] The final version 1.2 of *OpenDoc,* which was also launched in early 1997, was made available for the *Macintosh, OS/2, Windows,* and *AIX*.

OpenDoc was founded on *SOM (System Object Model),* a loosely *CORBA*-compliant *ORB* from *IBM.*[362] The technologies being part of *OpenDoc* corresponded closely to the constituents of its main competitor, *Microsoft's OLE*. Thus, it encompassed a structured storage technology, *Bento* from *Apple,* an *Open Scripting Architecture (OSA),* which corresponded to *OLE Automation,* support for *uniform data transfer* as well as compound document management, and a kind of programme components called *parts,* not dissimilar from *ActiveX Controls*. There was also a validation and branding programme for the *parts* components, *Live Objects,* managed by *CIL*. At the demise of *CIL,* only around 75 *Live Objects* were available, which well illustrates the failing market response to *OpenDoc*. This together with various technical problems, skyrocketing development costs, *Apple's* economic crisis at the time, the advent of the competing *JavaBeans* architecture, and *IBM's* failure to establish *OS/2* as a major contender on the personal computer operating systems market eventually killed the ambitious project. This untimely “death on arrival” may well be construed as marking off the end of the great war for the desktop between *Microsoft* and its various competitors, a war, which had then already metamorphosed into the great war for the *Internet*.

1.6.6 THE *CORBA COMPONENT MODEL (CCM)*

The *CORBA Component Model (CCM),* or *CORBAcomponents* for short, being the main attraction of the recently adopted *CORBA 3.0* specification, provides a language-independent container environment for middleware components, similar to *Microsoft's MTS/COM+* or *Sun's Enterprise JavaBeans.*[363] Apropos of the latter, existing *Enterprise JavaBeans* can be used as *CORBAcomponents* in a *CORBAcomponents* container, although *bona fide CORBAcomponents* can be written in many different languages besides *Java*. The *CORBAcomponents* container will handle transactionality, persistence, and security transparently, thereby supposedly making it easier for the component programmer to focus on the business issues of primary interest to him. Every *CORBAcomponent* possesses an arbitrary number of *ports,* of which there are four types:

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358 There are also various other, more clearly “vertical” or domain-specific facilities, such as the *Negotiation Facility,* the *Party Management Facility,* and the *Utility Management Systems (UMS) Data Access Facility*.

359 See [ACIN95].

360 The web site of *CIL* http://www.cilabs.org is of course no longer operative. [Pier94] is an interesting *BYTE* article on *OpenDoc* authored by Piersol, whereas [IBM94a], [Pfis95b] [Wayn96] [Lint96] are some other contemporary articles on *OpenDoc*. [JJ97] and [MS96] are two of a few books published on the technology. See also [OHE96b] p. 339 et seqq.

361 The public domain version of *OpenDoc* used to be available at http://www.ibm.com/software/ad/opendoc.

362 On *SOM,* see the books [Lau94] and [Hami97b] and the articles [IBM94b-c], [Box], [Pfis95b], [HKMT95], and [Hami96]. Cf. also [OHE96b] p. 208 et seqq. The *CORBA*-compliance of *SOM* was far from perfect, and the *IDL* files used in the version 2.0 of *SOM,* on which *OpenDoc* was based, were consequently replete with ugly *#ifdef _SOMIDL_ #endif* constructions. Nor did *SOM* by itself support the distribution of objects across machine-boundaries, for which its distributed sibling *DSOM* was instead needed.

363 See [OMG02b] and [Sieg00] p. 114 et seqq.

- *facets* are the ordinary call interfaces exposed by a component, but may in *CCM* be multiple
- *receptacles* are the interfaces the component needs to call in other components
- *event sources* are connection points for the events the component produces
- *event sinks* are connection points for the events which the component consumes

Component specifications are written in *CIDL (Component Interface Definition Language),* which is an extension of *CORBA IDL,* supporting the above new features as well as others. *CIDL* constitutes the core of the *Component Implementation Framework (CIF),* which is the programming model used by *CCM* developers. In addition, specifications of a *CORBAcomponents* software distribution format and installation and configuration tools are currently in process. There is of course much more to the *CORBAcomponents* technology, but since we cannot go into the complexities of middleware technologies and development here we will have to refer the interested reader to the literature.

1.6.7 THE SHIFTING GOALS AND FORTUNES OF THE *OMG* EFFORT

After a rather unspectacular start, *OMG* in the mid-90s became the focus of the intense "object wars", which at the time raged between *Microsoft* and a number of companies, including *IBM, Sun, Apple,* and *Novel,* that together struggled to thwart *Microsoft's* rapidly growing dominance in the market for desktop systems software. Many, in particular amongst the supporters of this anti-*Microsoft* league, believed or hoped that a major breakthrough for *CORBA* was about to happen in 1996 or 1997, which some analysts even ventured to denominate "the year of *CORBA",* and that this would imply that "open systems" would get the upper hand over *Microsoft's* purportedly "proprietary" technology.[364] This great breakthrough never happened – on the contrary, *OMG* and *CORBA* soon met with a number of setbacks, amongst which *IBM's* and *Apple's* marooning of *OpenDoc* in the limbo of public domain software was only one.

Firstly, the new programming language *Java,* suddenly beginning to exert an increasingly mesmerising hold on the vanguard of distributed and object-oriented programming, now loomed up as an unexpected competitor to *CORBA,* which it soon tended to overshadow and eclipse altogether. Notably, the rapidly growing technological infrastructure surrounding *Java*, albeit intended as a missile weapon against the *Microsoft* desktop empire, also hit *OMG's* turf on a number of spots. The most conspicuous examples will be the *JavaBeans* component model, which certainly was one of a number of factors conducive to the downfall of *OpenDoc,* and the easy-to-use *RMI (Remote Method Invocation) ORB,* which by its very accessibility became a formidable competitor of *CORBA* no less than of *Microsoft's DCOM.* Although *Sun* in the end decided to succour *CORBA* by, for example, offering *IIOP* as a wire protocol for *RMI* and promoting and blessing the *Java IDL CORBA* mapping[365], the challenge of the *object web* and the harmonisation of *CORBA* with the *Java* infrastructure were not only the tremendous opportunities described in *OMG's* promotional materials and policy statements, but also difficult and complex undertakings and sources of great uncertainty and unease, which took its toll on *OMG* as a whole and also wrought a major revision of the *OMG* agenda.

Secondly, the rate of progress of the implementations of the *CORBAservices* and the other *OMG* technologies remained sluggish. It took a long time before there was a full implementation of the *CORBAservices,* and not even the fundamental life cycle, naming, and event services could be taken for granted in commercial *ORB* products. This phlegm of the *CORBA* implementers was in stark contrast to the swift progress of *Microsoft's* and *Sun's* distributed objects and components effort, the key pieces of which were then one by one falling into place in usable real-world products. These problems also spotlight the weakness of the entire *OMG* approach with its drawn out specification process and its dependence on the strength and agility of the companies that finally are to implement the specifications adopted.

Additionally, the drift towards the proprietary, known also from some other "open" efforts, was haunting the *CORBA ORB* market and offered *Microsoft* an opportunity to stigmatise the state of affairs as "*CORBA*

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[364] See e.g. [OHE96b] p. 62 et seqq or [Harm97] p. 1. Behind the high-flown rhetoric on "open systems" of course also often lurked the rather obvious business interests of the companies, which saw their own revenues threatened by *Microsoft's* successes.

[365] See http://java.sun.com/j2ee/corba/index.html.

Chaos".[366] The compliance tests put together by the *Open Group* only mitigated these problems marginally, but by no means put an end to them, since these tests were concerned only with a subset of the core *ORB* functionality. Another matter of grief and distress for *OMG* was the *Ovum* report on object request brokers issued in 1997, which presented *CORBA* as a potentially "doomed standard" and a "flawed architecture"[367], a verdict fervently disputed by *OMG* representatives and supporters.[368]

Certainly, the demise of the unfortunate *OpenDoc* effort in early 1997 can be construed as a major blow to the entire *OMG* project, since a ***compound document architecture*** indeed is a crucial part of a component infrastructure and also was what *OMG* was originally intended to be all about. Above all, it was, however, a reflection and confirmation of *Microsoft's* success in the first, desktop-phase of the "object wars", after which the desktop market for operating and object systems was more or less ceded to *Microsoft* – except, of course, for the rather small niche markets where other systems, such as *Apple's Macintosh* or *UNIX* workstations, already had a strong hold. The former supporters of *OpenDoc* hereupon largely tended to focus their efforts on the middleware and server markets or to set their hopes to *Java* and the *JavaBeans* and *Enterprise JavaBeans* components – *IBM,* for example, started investing heavily in *JavaBeans* development. There was also now a shift of interest within *OMG* towards object-oriented analysis and design questions, ***business objects,*** and work on domain interface specifications, and for a time much interest focused on the ***business object facility,*** which was worked on by the *Business Object Domain Task Force (BODTF)*[369]*,* although this effort would some years later come a cropper.

The state of affairs then changed a little for the better through a paper written jointly by *IBM, Netscape, Oracle,* and *Sun* in mid-1997, apparently in an attempt to revitalise *OMG* after the demise of *OpenDoc.*[370] In this document, it was argued that *OMG* should expand and adapt the *CORBA* technologies so as to support a "component framework enabling *CORBA* objects, representing ***both client-side and non-visual server-side functionality,*** to be assembled into systems, using ***visual development tools*** and ***scripting languages,*** by unsophisticated programmers". In particular, this framework should interoperate with component standards such as *JavaBeans* and provide easy access of *CORBA* objects from *Java.* This paper attracted considerable attention and sparked the issuance of two *OMG RFPs*[371] concerning a *CORBA* component model and a *CORBA* scripting language, which recently have resulted in the two aforementioned adopted specifications of the *CORBA Component Model* and the *CORBA Scripting Language*.[372]

Today, *CORBA* has in actual fact been reduced to a niche – or perhaps even a legacy[373] – middleware technology, a far remove from the grand component vistas that seemed to open for it in the mid-90s, although *CORBAcomponents* may extend its importance on the transaction monitor, web server, and application server market somewhat, provided that the new specification will be able to gain the necessary support from major players on these markets. But in spite of the prospects of *CORBAcomponents,* the presently most significant and widely used outcome of *OMG's* various efforts will doubtless be the *UML* modelling standard and the various specifications supplementary to it, which also are free from the aura of controversiality and political struggle that still attaches to *CORBA* and the *CORBA*-related technologies. Also *OMG's* domain activities seem to be rather bustling today, although the extent to which the technologies worked upon here really will show up in real-world products is difficult to assess and in any case is likely to differ widely between different domains.

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[366] [Micr97c]

[367] For a summary, refer to [Rock97a] and [Rock97b]. The conclusions of this report implied a somewhat unexpected tergiversation in opinion on the part of *Ovum,* which a year earlier had reportedly predicted a ten billion dollar *CORBA* market by the year 2000.

[368] See [OMG97i], [Wels97a], and [Wels97b].

[369] See, for example, [Morg97] p. 4, where Christopher Stone, then still the president of *OMG,* is quoted as saying that *OMG* is "building the road to business objects".

[370] [OMG97d]

[371] [OMG97e-f]

[372] [OMG02b] and [OMG01c].

[373] [Adhi02]

1.7 *JAVA* AND *JAVABEANS* – IN PURSUIT OF PORTABLE COMPONENTS

What makes a programming language successful, if we by "successful" mean really, really successful? Apparently, for a language to succeed on the grand scale, it should first of all have a clearly defined domain of usage, which must not be too small. Secondly it should be available – or at least be about to enter the lists – at the critical point in time, when the need for a language for this very domain for one reason or other becomes widespread and, in some sense, imperative. By these two factors, the success of most of the "great" classical programming languages can be rendered comprehensible. For example, *FORTRAN* responded to the need for a tool for the mathematically oriented *computing* typical of the early days of computer systems, and *COBOL* likewise filled the growing need for *business-oriented programming,* which arose a little later. And all since the early 60s, *BASIC* has served as the *beginner's language par préférence,* whereas *Pascal* became the preferred language for *Academic training* of programmers. The 70s (and 80s) made *C* the language of choice for *systems programming,* and its object-oriented successor *C++* gained widespread popularity around 1990 largely due to the need for a better way to do *GUI-oriented systems programming. Visual Basic* considerably reduced the complexities of such *GUI programming* for *Windows,* which turned out to become the by far most widespread of a number of competing *GUIs.*[374] That all these programming languages became so tremendously successful was above all a consequence of the largeness of their domain of usage. Some languages, of which the domain was much smaller, have had an accordingly more modest success, such as, for instance, *SIMULA* in the computer simulation domain, *Lisp* in artificial intelligence, *MUMPS* in healthcare software, or *Prolog* in linguistic programming.

Of late, *Java* has gained its immense current popularity by filling the suddenly urgent need for an *Internet programming* language. In particular, its *bytecode*-based execution model as implemented by the *Java Virtual Machine (JVM)* provided the support for cross-machine portability and security required in *Internet* programming. In particular, *applets,* small programme components written in *Java* inserted on an *HTML* web page, paved the way for the success of *Java* by liberating the web page designer from the narrow shackles of purely static *HTML* code. Such *applets* are downloaded as machine-independent *bytecodes* together with the web page that hosts them and are then run locally on the *Java Virtual Machine* supported by the particular *Internet* browser used. Most importantly, the downloaded *Java* bytecodes can easily be prevented from making potentially dangerous operating system calls, such as removing files or formatting disks, by being executed within a protective *sandbox,* through which the local machine is shielded from maliciously written programme code.

Ironically, the strength of *Java* soon also became its weak spot – the tantalising slowness inherent in applet download and bytecode interpretation became a recurrent topic of *Java* criticism and tended to undermine much of the first enthusiasm that had met the language. Since these early days, *Java* applet programming has largely been abandoned in web page design for faster and more recent display technologies based on *Dynamic HTML (DHTML)* and *XML.* Instead, *Java* has gained new ground in web server programming and also in conventional object-oriented programming as a "better *C++*". In addition, the virtual machine approach can easily be extended to other languages or be made to support multiple languages as exemplified by *Microsoft's .NET Common Language Runtime.*[375]

As the "desktop wars" of the early 90s were ensued by the *"Internet* wars" of the latter portion of the decade, the *Java* language became a major combat zone in the struggle for market and mind share between *Microsoft* and its competitors, among which *Sun, IBM, Oracle,* and *Netscape* – sometimes referred to as "the gang of four" – were most prominent and most bellicose. Simply put, *Sun* and its friends hoped that *Java* would help to liberate them from the stranglehold of the ever-growing *Wintel* domination, which threatened the business interests of them all – although in quite different ways. They hatched a grandiose vision of *Java* and its class libraries as a kind of portability layer or portable operating system, which would support a variety of functionality traditionally implemented by the operating system and iron out the dissimilarities of the different underlying systems. Such a *WORA (Write Once, Run Anywhere)* portability layer would make it possible for developers to target not only the operating system where the largest profits were to be reaped, that is to say *Microsoft's Windows,* but all systems where the *Java* programming language and its libraries are available, provided that the *Java* system layers are closely compatible across the different systems. This would of course

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374 [Gabr96] p. 112 identifies a number of critical success factors for computer languages, including modest resource requirements, a simple performance model, and small demands on users as to mathematical sophistication. Cf. also [DSPI97] p. 2 et seqq.

375 [Sess01b] sets out to debunk the myth of the language-neutrality of *Java* bytecodes.

make it easier for operating systems other than *Windows* to persist simply by being able to run any programme delivered as *Java* bytecodes.

There are of course some flaws to this alluring vision as well. Firstly, it seems rather unlikely that all the world's programmers should be willing suddenly to be converted into *Java* programmers. Secondly, bytecode interpretation is too slow for many, if not most, kinds of real-world applications, although this problem can of course be addressed by all kinds of optimisation techniques or simply by compilation – or, perhaps often preferably just-in-time compilation – of the bytecodes into binaries. Thirdly, portable programme code is riddled with the well-known "least common denominator problem", and, consequently, cannot take advantage of the full range of capabilities of all the environments it supports. This will be particularly obvious in the *GUI* of such portable programmes, which will usually look dull, odd, or simply not quite up to the mark, which, in particular, will be a great drawback in the very competitive *PC* software market. There are various techniques to mitigate these problems, such as the "greatest common denominator approach", where the portability layer will support the platform-specific features also on the platforms where they are not supported by the systems software, but none of these will be quite satisfactory.

Among the functionality included in the *Java* portability system, the huge *GUI APIs* of the *AWT* and *JFC* frameworks are of course keystones.[376] More relevant to the theme of this thesis are the *JavaBeans* components and the *RMI (Remote Method Invocation)* broker technology. These are fundamental building blocks of the *Java Enterprise* platform, which is made up of many more technologies – some of these will be very briefly discussed below – and primarily targets the realm of middleware and server systems.

1.7.1 *RMI* – REMOTE METHOD INVOCATION

A *Java* interface that extends the *Remote* interface is called a *remote interface,* and its methods can be invoked by remote clients over a network or the *Internet.* An example will illustrate how this is done: Firstly the interface of the remote object has to be declared:[377]

```
import java.rmi.*;

public interface IMyServer extends Remote {
   Object do(Object obj) throws RemoteException;
}
```

This code snippet shows that the *RMI* system is located in the `java.rmi` package, that remotely called methods may throw a `RemoteException,` and that *RMI* supports passing objects by value – to wit through serialisation and a deep copy – to and from a remote method, although there is also in *RMI* the option of passing *remote objects* (N.B.!) by reference. An, admittedly somewhat silly, implementation of the `MyServer` interface may look like this:

```
import java.rmi.*;
import java.rmi.server.*;

public class MyServer extends UnicastRemoteObject implements IMyServer {
   public MyServer () throws RemoteException { super();}
   Object do(Object obj) throws RemoteException { return obj;}
   public static void main(String[] args) throws Exception {
      System.setSecurityManager(new RMISecurityManager());
      IMyServer s=new MyServer();
      Naming.rebind("MyServer",s);
   }
}
```

[376] Portable *GUI* class libraries and frameworks have been available for long in *Smalltalk,* and many commercial products that address the *GUI* portability problem have been developed, in particular in the early 90s.

[377] *Sun's RMI* documentation is available at http://java.sun.com/products/jdk/rmi. Good accounts of *RMI* are found in [AW99] p. 325 et seqq. and [Roma99b] p. 505 et seqq. The example given above has been adapted from the *RMI* example in [AG97] p. 362 et seqq.

Most remote object classes will derive from the class `UnicastRemoteObject,` which makes the object available for remote invocations as soon as it has been created.[378] Usually, each invocation of a remote method is run in its own thread. Since in *RMI* objects are by default passed not by reference, but by value, the code of the passed objects is potentially unsafe and, thus, needs to be properly sandboxed. The `RMI-SecurityManager` is a comparatively conservative security manager, which may be replaced by one of one's own making, if a special security policy is desired. The `Naming` class represents the *RMI registry,* where all remote objects must register themselves in order to become available for remote invocation.

After the implementation and interface source files have been compiled to bytecodes by the *Java* compiler, the resulting *.class* files must be compiled again by a special *RMI compiler (rmic).* The *rmic* compiler generates a *stub* (i.e. a client-side proxy) and, optionally, a *skeleton* (a server-side proxy) *.class* file, of which the latter is not really needed in *Java 2,* where instead generic skeletons being part of the *RMI* run-time can be used in most cases.

The source code for the client may look like this:

```
import java.rmi.*;

public class MyClient {
   public static void main(String[] args) throws Exception {
      IMyServer s;
      Object obj=new Object();
      System.setSecurityManager(new RMISecurityManager());
      s=(IMyServer)Naming.lookup("rmi://www.cs.lth.se/MyServer");
      obj=s.do(obj);
   }
}
```

The client asks the *RMI registry* for a reference to the remote object it wishes to access and calls the `Do` method on this object. As can be seen by this simple example, *Java RMI* provides *Java* programmers with a very easy-to-use object broker as well as support for mobile objects. Via *IIOP* a remote object may also interact with *CORBA* objects and, thus, objects written in other languages than *Java,* although the cost for such interoperability will be paid through a loss of the simplicity that is one of the main benefits of *RMI.*

1.7.2 *JAVABEANS* – COMPONENTS FOR THE *INTERNET*

In *December* 1996, the *JavaBeans 1.0* specification, defining a software component model for *Java,* was presented[379], and some months later the *JavaBeans APIs* were released as *BDK (Bean Developer's Kit) 1.0* together with the *JDK (Java Development Kit) 1.1.* Some quite consequential additions to *JDK* were in fact necessitated by the needs of *JavaBeans,* including support for reflection, serialisation, *Uniform Data Transfer* (i.e. cut and paste) and *JAR* archive files.[380] On the surface, *JavaBeans* may appear to emulate the features of *Microsoft's ActiveX controls* quite closely, just like these exposing events, methods, and properties to their users. The technical foundation of *JavaBeans* is, however, not very close to that of the *Microsoft* technologies; *Microsoft's* own shifts from *VBXs* to *OCXs* to *.NET* components prove that it is possible to base such visual, superficially similar components on very different substructures.

JavaBeans is in many respects technically simpler than *OLE/ActiveX* or *OpenDoc* components and have been deliberately designed to be uncomplicated and lightweight in order to make downloading over the *Internet*

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[378] There are also other classes, which an *RMI* class may extend, including *java.rmi.activation.Activatable,* which lets the remote objects be loaded into memory "on demand", and *javax.rmi.PortableRemoteObject,* which uses *IIOP* as its transport protocol, thereby facilitating interoperability with *CORBA* clients.

[379] [Java96]. [Hami97a] is the current slightly revised 1.01 version of the specification, which remains the best guide to the *JavaBeans* technology. More information is available at http://java.sun.com/products/javabeans. There are also numerous books on *JavaBeans,* such as [Srid97], [Morr97], or [Wats98], just to name a few.

[380] See [Hami97a] p. 6 and p. 21.

feasible.[381] The simplicity of *JavaBeans* is partly due to some complexity-reducing design decisions (such as its "design pattern" conventions) and the exploitation of the reflective facilities of the *Java* language, but also to the fact that the goals of *JavaBeans* are considerably less ambitious than those of *OLE/ActiveX* or *OpenDoc*. In *JavaBeans,* there is, for example, currently no support for advanced compound document functionality or the integration of components, which execute in different processes[382], although a future version code-named *Edinburgh* was earlier planned to encompass some compound document features such as menubar and toolbar merging.[383]

For *JavaBeans* to interoperate with existing component technologies, bridges are used. For example, *Sun* provides a bridge between *JavaBeans* and *ActiveX,* which makes it possible to treat a *Java Bean* as an *Active X* control from an *ActiveX* container, and *Stryon's R-JAX (Remote Java ActiveX Server)* facilitates the access of *Windows COM* objects, *ActiveX controls,* and *DLLs* from *JavaBeans.*[384] There have been plans for bridges to *OpenDoc* and *Netscape's LiveConnect* as well, although these were never realised.[385]

1.7.2.1 What Is a Java Bean?

In the *JavaBeans* specification, Graham Hamilton, the main architect of *JavaBeans,* defines a *Java Bean* thus:[386]

> *A Java Bean is a reusable software component that can be manipulated visually in a builder tool.*

He also enumerates various categories of such builder tools, including web page builders, visual application builders, *GUI* layout builders, server application builders, or even simple document editors. Some of these tools are primarily geared towards assembly of visual components, whereas others are more oriented towards construction of programme code, and others still may target high-level scripting.

A bean is characterised by the *properties, methods,* and *events* it supports. *Properties* are the published attributes of the bean, and *methods* are its published operations. *Events* are generated by the bean, which is then said to act as an *event source,* and propagated to all *event listeners* that have registered their interest in a particular event with the bean. A bean usually has two distinct modes of operation:

- *design-time* operation is the mode used within builder tools, which provide support for the insertion of beans into forms and the subsequent customisation of these beans
- *run-time* mode is used within a running application[387]

Furthermore, a *Java* bean must support a number of "unifying features":[388]

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[381] Also the requirements on *ActiveX* components as compared to the *OCXs,* which preceded them, were loosened so as to make them more lightweight and fit for *Internet* usage. See [Denn97] p. 395 et seqq.

[382] It is, however, possible to link a bean to objects in another process or on another machine through *RMI* or a *CORBA ORB* that supports *Java IDL*. A bean may also connect to data in a database through *JDBC* or *JDO (Java Data Objects)*.

[383] Cf. [Hami97a] p. 111 and p 7, where two kind of uses of *JavaBeans* are mentioned, viz. as small to medium-grained "building blocks" for application composition and as "regular applications" that may be composed into compound documents. There is no stark division line between composite applications and compound documents, but rather a continuum.

[384] See http://java.sun.com/products/javabeans/software and http://www.stryon.com/products.asp?s=2.

[385] See [Hami97a] p. 7 et seq.

[386] [Hami97a] p. 9.

[387] The *java.beans.Beans* class provides a method *isDesignTime,* through which it is possible to determine the currently effective mode. Another method *isGuiAvailable* makes it possible to check whether the bean is run in a *GUI*-enabled environment or not.

[388] [Hami97a] p. 9.

- *introspection,* which enables builder tools to discover the events, properties and methods of a bean
- *events*
- *properties*
- *persistence,* which is used to save the customised state of the bean
- *customisation,* usually accomplished by modification of the *properties* of the bean

A bean is primarily useful for the packaging of pieces of software that need to be visually manipulated or customised in a "builder tool", whereas a conventional class representation will be more appropriate for many other pieces of reusable software, such as low-level data structures, strings, or complex numbers. Invisible beans may make sense in some contexts, and although such beans cannot be seen at run-time, they can of course be visually manipulated and customised at design-time like all beans. For instance, *Enterprise JavaBeans* are transactional middleware components, which as a rule lack a user interface.[389]

The *JavaBeans* technology complies with the usual *Java* security model. Consequently, if a *Java Bean* is run as part of an untrusted applet, the customary sandbox restrictions will apply and the bean will be prevented from performing any potentially harmful operations such as writing to the hard disk of the computer. In trusted applets or ordinary applications there are, of course, no such restrictions on what may be done inside a bean.

1.7.2.2 Introspection

Introspection is the mechanism which builder tools use to discover the properties, events, and methods of a bean. There are two ways for a bean to specify these particulars, viz. by means of *design patterns* or through a class that implements the *BeanInfo* interface. *Design patterns* are here understood as "conventional names and type signatures for sets of methods and/or interfaces".[390] There are such design patterns for simple, boolean, and indexed properties, for multicast and unicast events, and for methods. Alternatively, a class implementing the *BeanInfo* interface can be provided, which will be useful, for example, if code not originally designed as a bean needs to be integrated into one. A *BeanInfo* object will include methods for the retrieval of:

- a *BeanInfo* array holding *BeanInfo* objects with additional information
- a *BeanDescriptor* object, which contains the *Class* object of the bean and its *customizer Class* object, if such an object exists[391]
- *MethodDescriptor, EventSetDescriptor,* and *PropertyDescriptor* arrays containing introspective data about the methods, events, and properties of the bean
- the *default property* and *default event* indices, which qualify a property and an event as the "default" in certain contexts
- any of four possible types of icons[392]

A *SimpleBeanInfo* class provides default (no-op) implementations of the methods of the *BeanInfo* interface. This class can be extended during the implementation of a *BeanInfo* object, providing an opportunity to override only the methods that need to be implemented. Another class *Introspector* may be used to create a *BeanInfo* object automatically for any bean class. *Introspector* either uses an existing *BeanInfo* object or, if no such object exists, builds its own by using the reflective capabilities of the *Java* language. The *Introspector* class is typically taken advantage of by builder tools for the purpose of finding out about the properties, events, and methods of a bean.

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[389] Visible beans inherit from *java.awt.Component.*

[390] [Hami97a] p. 54. The term *design pattern* is sensibly criticised in [Szyp98a] p. 234, where *method pattern* is proposed as an alternative name.

[391] For more information about *customizers,* see below p. 93.

[392] This piece of information is optional.

1.7.2.3 Events

JavaBeans adopts the enhanced "delegation-based" event handling mechanism of the *AWT (Abstract Window Toolkit)* framework, which came with *JDK 1.1*[393] and, unfortunately, also rendered much old *Java* code obsolete overnight. In this model, the originator of an *event notification* is referred to as an *event source*. External parties that register their interest for a certain event with such an event source are called *event listeners*. To be able to listen for a category of events, *event listeners* will have to implement an *event listener interface* that accommodates one or more event notification methods. The event source delivers the *event notifications* to the registered listeners by calling the corresponding method of the event listener interface on each listener. Event notification methods usually take only one argument, viz. an *event state object,* which in it holds any pieces of information relevant to the event. Additionally, an *event adaptor* object implementing a particular listener interface may be inserted between the event source and the listener proper so as to decouple source and listener.

Event notifications are implemented as methods conforming to *design patterns,* i.e. signatures where certain conventions pertaining to the choice of arguments and names are observed:

```
void <EventNotificationMethod>(<EventStateObject> ev);
```

The argument of such a method is usually an event state object, although arbitrary argument lists may be used under "exceptional circumstances", as when, for instance, events are forwarded to external environments that expect a particular set-up of arguments. Furthermore, an event notification method may throw checked exceptions.[394] Event notification methods are grouped in *event listener interfaces,* which inherit from *java.util.EventListener* and by convention have names that end in *"Listener"*.

Event state objects are used as arguments to event notification methods. The class of an event state object represents a certain event and by convention has a name that ends in *"Event"*. Such classes are derived from *java.util.EventObject*. Event state objects should be immutable and their attributes should only be accessed through accessor methods. Typical source code for a listener interface may look like this:

```
public class ExampleEvent extends java.util.EventObject {
   protected int x,y;
   ExampleEvent(java.awt.Component src,int x1,int y1) {
      super(src); x=x1; y=y1;
   }
   public int getX() { return x; }
   public int getY() { return y; }
}

interface ExampleListener extends java.util.EventListener {
   void exampleHappened(ExampleEvent ev);
}

class ListenerClass implements ExampleListener {
   void exampleHappened(ExampleEvent ev) { … }
}
```

Event sources define listener registration methods, which conform to this design pattern:

```
void add<EventListenerType>(<EventListenerType> l);
void add<EventListenerType>(<EventListenerType> l)
                          throws java.util.TooManyListenersException;
void remove<EventListenerType>(<EventListenerType> l);
```

The first design pattern for the *add* method is the one mostly used and supports *multicast* listener registration, whereas the second one provides support for *unicast* registration. If the *unicast* registration variant is opted for, a *java.util.TooManyListenersException* exception should be thrown, in case an attempt to register more than

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393 See [AG97] p. 360 and [Hami97a] p. 24 et seqq.

394 *Java* supports checked as well as unchecked exceptions. The former must be declared in the *throws* clause of the method that may throw the exception, whereas the latter do not need to be listed in a *throws* clause. See [AG97] p. 152 et seqq.

one listener is made. If the bean is supposed to be used in a multithreaded context, the registration methods should be *synchronized*.

When there is more than one listener, the order of event delivery is undefined. What happens, if an exception is thrown during event delivery, is also implementation-dependent. Event delivery is synchronous and when the event source calls the event notification methods of the listener, it must not hold any locks lest deadlocks occur. Consequently, neither the event source method firing the event notifications, nor the event notification methods themselves should be *synchronized*. Access to the data structures that hold the event listeners should, however, be *synchronized* to avoid race conditions – this is the reason why the registration methods should be *synchronized* in a multithreaded application. One way of doing an event notification in such a programme is to copy the listeners inside a *synchronized* block and then, having released the lock on this block, fire the events on the copied listeners:[395]

```
Vector listenersVector=new Vector();
…
protected void notifyExampleHappened(int x,int y) {
    Vector v;
    EventObject ev=new ExampleEvent(this,x,y);
    synchronised(this) { v=(Vector)listenersVector.clone(); }
    for (int i=0; i<v.size(); i++)
        ((ExampleListener)v.elementAt(i)).exampleHappened(ev);
}
```

In a multi-threaded environment, it is recommended that the methods of a bean should be made *synchronized*.[396] However, when an event notification is propagated from the event source bean to its listeners, the bean must not, as explained above, hold any locks in order to avoid the risk for deadlocks.[397] Since event notifications often follow upon changes in the state of a bean and, thus, may be initiated by an accessor method, these requirements are in conflict with each other.

Event listeners implement one or many *event listener* interfaces, which they register with *event sources*. When convenient, an *event adaptor,* which implements the *event listener* interface expected by the event source, may be interposed between the source and listener. The event adaptor may add some useful functionality such as event queuing, filtering, or demultiplexing of events from different sources onto different target methods in the listener, or it may just be used by rote, for instance by a builder tool, which synthesises adaptor classes for all events. One problem with adaptor classes is that they tend to become very numerous, if the number of event sources is high. The *local inner classes*[398] or *anonymous classes*[399] of *Java* may be used to reduce the resulting code bloat a little.[400]

1.7.2.4 Properties

The *properties* of a *Java* bean are attributes intended for exposure in a *property sheet*. Notably, properties are easily accessible in scripting environments such as *JavaScript* or *VBScript* through "dot notation". In most cases, properties are persistent and will be saved as part of the state of the bean they belong to. Properties are accessed through *getter* and *setter* methods, which conform to simple *design patterns* and may throw checked exceptions:

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[395] [Hami97a] p. 30 et seq. The specification states that the effect of modifications on the set of listeners during event delivery is unspecified, so an implementer may for performance reasons choose not to do the rather resource-demanding copy, thereby, however, hazarding the integrity of the listeners during certain unusual circumstances.

[396] [Hami97a] p. 14

[397] [Hami97a] p. 31. Cf. also [Srid97] p. 81 et seq. and [Szyp98a] p. 232.

[398] See [AG97] p. 53 et seqq.

[399] See [AG97] p. 74 et seq.

[400] Another way to avoid the proliferation of event adaptors, which primarily may be taken advantage of by builder tools, is to use a *generic demultiplexing adaptor* as described by [Hami97a] p. 35 et seq. Such an adaptor uses reflection for method lookup and the *java.lang.relflect.Method::invoke* operation to call the appropriate target method.

```
public void set<PropertyName>(<PropertyType> val);
public <PropertyType> get<PropertyName>();
```

The getter method for boolean properties has a slightly different signature:

```
public boolean is<PropertyName>();
```

Properties may also be arrays indexed by an integer. Such properties may be accessed either element by element through the index or as a whole array:

```
public void set<PropertyName>(int i, <PropertyType> val);
public <PropertyType> get<PropertyName>(int i);
public void set<PropertyName>(<PropertyType> vals[]);
public <PropertyType>[] get<PropertyName>();
```

Furthermore, a *bound property* notifies registered *property change listeners* about changes of its value. Property change listeners implement the *java.beans.PropertyChangeListener* interface and register themselves with the bean through the methods *addPropertyChangeListener* and *removePropertyChangeListener,* which are implemented by the bean:

```
public void addPropertyChangeListener(PropertyChangeListener p);
public void removePropertyChangeListener(PropertyChangeListener p);
```

Alternatively, a property change listener may register interest in just a certain property:

```
public void addPropertyChangeListener(String propertyName,
                                      PropertyChangeListener p);
public void removePropertyChangeListener(String propertyName,
                                         PropertyChangeListener p);
public void add<PropertyName>Listener(PropertyChangeListener p);
public void add<PropertyName>Listener(PropertyChangeListener p);
public void remove<PropertyName>Listener(PropertyChangeListener p);
```

The bean may utilise the helper class *java.beans.PropertyChangeSupport* for the implementation of bound properties. In any case, after a property change, *PropertyChangeListener::propertyChange* should be called for all property change listeners, which have registered interest either for the properties of the bean in general or for the particular property that just changed.

By the same token, it is possible to define *constrained properties* that may change only if none of any registered *vetoable change listeners* objects to the change. The setter function of such a property will include the *PropertyVetoException* in its *throws* clause and this exception will be thrown if any *vetoable change listener* does not assent to the proposed change:

```
public void set<PropertyName>(<PropertyType> val) throws PropertyVetoException;
public <PropertyType> get<PropertyName>();
```

Vetoable change listeners implement the *java.beans.VetoableChangeListener* interface and register themselves with the bean through the methods *addVetoableChangeListener* and *removeVetoableChangeListener,* which must be implemented by the bean:

```
public void addVetoableChangeListener(VetoableChangeListener v);
public void removeVetoableChangeListener(VetoableChangeListener v);
```

Alternatively, a vetoable change listener may register interest just for a certain property:

```
public void addVetoableChangeListener(String propertyName,
                                      VetoableChangeListener v);
public void removeVetoableChangeListener(String propertyName,
                                         VetoableChangeListener v);
```

```
public void add<PropertyName>Listener(VetoableChangeListener v);
public void remove<PropertyName>Listener(VetoableChangeListener v);
```

The bean may take advantage of the helper class *java.beans.VetoableChangeSupport* for the implementation of constrained properties. Before a property change, *VetoableChangeListener::vetoableChange* must be called for all listeners, which have registered interest for the properties of the bean in general or for the particular property that is about to be changed. If anyone of these throws a *PropertyVetoException,* the old value should be restored and *VetoableChangeListener::vetoableChange* calls issued in order to inform all listeners that have already consented to the change that the old value has been restored.[401] A property may be both bound and constrained. In this case, the vetoable change listeners are called first and the regular property change listeners only after the change has actually been made, in case no vetoes were issued. Additionally, if a setter method is called with a value that equals the current value of the property, no listeners should be called at all.

1.7.2.5 Methods

The public methods of a *Java Bean* are regarded as its *methods.* This includes getter and setter methods for its properties as well as the various listener methods discussed above.

1.7.2.6 Persistent Storage

Support for *serialisation* or *externalisation* is mandatory for a *Java* bean. *Serialisation* is the easier choice of the two, since it is effected simply by the bean's "implementing" the *java.IO.Serializable* interface, which contains no operations, and marking as *transient* any data that should not be persistent. Serialisation is then handled automatically. *Externalisation* gives the bean control of the writing and reading of data. A bean designer, who wants to support externalisation, does so by implementing the *java.IO.Externalizable* interface, including the *writeObject* and *readObject* methods. As an alternative to serialisation and externalisation, a builder tool may generate initialisation code that restores the values of the properties of the bean when the bean is activated at run-time. This only works for *properties* – if the bean contains hidden state (i.e. non-transient attributes that are not properties), serialisation or externalisation must be used.[402]

The JAR file format is often used for the packaging of *JavaBeans* and their "pickled state", although any file format may in fact be used.[403] A JAR file is an archive file on the ZIP format to which may optionally be added a *manifest file* containing a description of the contents of the file. A JAR file may contain class files, the pickled state of objects, HTML help files, internationalisation info, images, and various resource files. Generally speaking, beans should not be created by the *new* operator, but by calling the *Beans.instantiate* operation, which is capable of loading a serialised bean automatically as well as of some other useful tricks.[404]

1.7.2.7 Customisation

A user *customises* a *Java Bean* at design-time by assigning values to its properties. *JavaBeans* supports two different methods of customisation. The more common one of the two lets the user edit the properties through a *property sheet,* in which various *property editors,* each tailored to a certain data type, are taken advantage of. *JavaBeans* provide property editors for the primitive types *boolean, byte, short, int, long, float,* and *double* as well as for strings, colours, and founts (i.e. the *Java* classes *java.lang.String, java.awt.Color,* and *java.awt.Font.).* A bean or a tool provider may add its own specialised property editors by implementing the *java.beans.PropertyEditor* interface and, to do so, it may exploit the helper class *java.beans.PropertyEditorSupport.* A *java.beans.PropertyManager* class is used by builder tools to find the editors for given types.

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401 If anyone of these vetoes the reversion, it may be necessary to ignore this veto.

402 A bean may indicate that it has hidden state by setting a flag "hidden-state" in its bean descriptor to true. See [Hami97a] p. 23.

403 [Hami97a] p. 102 et seqq.

404 [Hami97a] p. 96.

For a complicated bean, a *customizer* may simplify matters considerably by providing a visual *wizard* that will guide the user through the customisation process. *Customizers* usually run in a dialogue box and derive from *java.awt.Component* either directly or indirectly. In addition, they should implement the *java.beans.Customizer* interface. After customisation, the "pickled state" of the bean should be saved through the serialisation or externalisation mechanism so it can be properly restored at run-time.

1.7.2.8 Further Developments

Early on, two future versions of *JavaBeans* code-named *Glasgow* and *Edinburgh* were announced by *Sun*. *Glasgow* was finally released in April 1999 as part of version 1.1 of the *BDK (Bean Development Kit),* which in turn was part of *Java 2,* formerly code-named *JDK 1.2,* whereas the plans for *Edinburgh,* which always were quite vague, have not, as yet at least, materialised. *Glasgow* encompasses three specifications:[405]

- *The JavaBeans Runtime Containment and Services Protocol* facilitates the hierarchical nesting of beans inside each other and makes it possible for a bean to query its container about its attributes and services. It also provides supports for the registration of listeners with a context, which may thus keep interested listeners notified of its changes.[406]

- *The Drag-and-Drop Subsystem for the Java Foundation Classes (JFC)* provides support for drag-and-drop interaction between *Java* and native applications.[407]

- *The JavaBeans Activation Framework* facilitates the use of beans as content viewers for data described by a *MIME (Multipurpose Internet Mail Extensions)* type definition in a way reminiscent of that used by an *Internet* browser to display data encoded in various formats by enlisting the assistance of various viewer programmes.[408]

The JavaBeans Runtime Containment and Services Protocol and *the Drag-and-Drop Subsystem for JFC* are both part of *Java 2,* whereas *the JavaBeans Activation Framework* is classed as a "standard extension", for which *Sun* provides a reference implementation.[409] Originally, *Glasgow* was meant to support aggregation of objects as well, thereby making it possible to have a bean comprise multiple objects, but this feature was later postponed.[410] The plans for the *Edinburgh* version included support for various compound document features, such as toolbar and menubar merging as well as online help and structured storage.

An interesting add-on to *JavaBeans* is the *InfoBus* (also known as *Kona InfoBus)* developed by *Lotus.*[411] This piece of software implements a *software bus*[412] intended for the dynamic interchange of data between beans and applets within one and the same *Java Virtual Machine.* It lets *data producers* publish data on the bus and *data consumers* subscribe to such data. Additionally, *data controllers* may regulate the flow of data between producers and consumers in various ways.[413]

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[405] See [Hami97a] p. 111 and [Mohs98].

[406] [Cabl98b]

[407] [Cabl98a]

[408] [CS99]. See also http://java.sun.com/products/javabeans/glasgow/jaf.html.

[409] "Standard extensions" are now also called "optional packages".

[410] In preparation for this extension, the programmer is recommended to use the *Beans.isInstanceOf/getInstanceOf* when handling beans instead of the standard *Java instanceof* operator and explicit casts. See [Hami97a] p. 14 et seq. and p. 97.

[411] See [Cola99], [Hoqu99], and http://java.sun.com/products/javabeans/infobus.

[412] *Software buses* originally met the need for the flexible interconnection of different software development tools. See [Reis90].

[413] In 1997, *Netscape* announced another technology, *BeanConnect,* which lets *JavaBeans* (and some other executable web page content) share a single *Java* execution space across different *HTML* pages. Whereas *InfoBus* is officially backed up by *Sun* and to be regarded as an extension of the *JavaBeans* specification, *BeanConnect* is a proprietary technology supported in *Netscape's* browsers, but *not* officially endorsed by *Sun.* See [Nets97b], [Nets99], and [Hoqu99] p. 88 et seqq. Cf. also http://java.sun.com/products/javabeans/faq/faq.beanconnect.html.

1.7.3 ENTERPRISE JAVA AND *ENTERPRISE JAVABEANS*

Sun's rapidly growing collection of enterprise technology specifications largely corresponds to *Microsoft's DNA* and *.NET* technologies, as can easily be seen from an enumeration of some of its highlights:[414]

- *RMI (Remote Method Invocation)* and the *Java CORBA* mappings correspond to *Microsoft's DCOM* and *.NET Remoting*
- *JDBC (Java Database Connectivity)* corresponds to *ODBC*
- *JDO (Java Data Objects)* corresponds to *ADO*
- *Java Servlets* correspond to various *Microsoft* server page component technologies
- *JSP (Java Server Pages)* corresponds to *ASP*
- *JNDI (Java Naming and Directory Interface)* corresponds to *ADSI* and the *Active Directory*
- *JMS (Java Message Services)* corresponds to *MSMQ*
- *JTA (Java Transaction API)* corresponds to *OLE Transactions*
- *EJB (Enterprise JavaBeans)* corresponds to *MTS/COM+*
- various *XML* and web services technologies correspond to similar *Microsoft* technologies

Most of the above technologies are part of *Java 2, Enterprise Edition (J2EE)* and may occasionally also be "optional packages" of *Java 2, Standard Edition (J2SE).*[415] Except for *Enterprise JavaBeans,* they are, however, not part of the *JavaBeans* component effort, but are based on the traditional object-oriented programming model of *Java* and, thus, need not concern us further here.

Enterprise JavaBeans (EJB) is *Sun's* specification for *Java* middleware components intended for use in *EJB*-compliant "containers" such as, for example, transaction monitors or applications servers.[416] The *Enterprise JavaBeans 2.0* specification is quite a complex document and cannot be examined here. Suffice it to say that it makes a fundamental distinction between *session, entity,* and *message-driven beans. Session beans* are similar to *Microsoft's COM+* components, being primarily intended as short-lived, stateless or stateful, packets of code for transactioned database updates, whereas *entity beans* are meant to impersonate long-lived "business objects", which represent specific data – typically a record – in a database.[417] Unlike a *session bean,* an *entity bean* is quite a complicated construct, which must have a unique key, use transactions directly, support multiple simultaneous users, and be able to survive a system crash. Notably, it may either load and save its data itself *(bean-managed persistence)* or delegate these tasks to its container *(container-managed persistence). Message-driven beans* are similar to *session beans,* but are asynchronously invoked through the *Java Message Service.*

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[414] Some books that treat of the *Enterprise Java* technologies are [DDS02], [AW99], [Roma99b], [FFCM99], and [Berg98].

[415] See [Shan02]. Cf. also http://java.sun.com/j2se and http://java.sun.com/j2ee.

[416] [DYK01] is the current 2.0 version of the *Enterprise JavaBeans* specification ([MH98] is version 1.0). See also *Sun's EJB* pages at http://java.sun.com/products/ejb/index.html. [Loeb02] states that there currently are more than 30 *J2EE* compliant application servers, although most of these will be rather marginal products. *Sun's J2EE* compatibility page enumerates about half that number of products (see http://java.sun.com/j2ee/compatibility.html), whereas, as per November 2002, the number of licensees of the *J2EE* technology (see http://java.sun.com/j2ee/licensees.html) is 35. In any case, *BEA's WebLogic* and *IBM's WebSphere* dominate the *J2EE* application server market, each having a market share of 34% in 2001, while *Oracle, Sun, Hewlett-Packard,* and *Sybase* had market shares in the range 3-7% (see [Wong02]). Since the *J2EE* specification does not encompass all the functionality needed in an application server, the compatibility between *Java/EJB* code written for different applications servers is typically limited. For example, *IBM* has published a redbook of 268 pages on how to port code written for *BEA's WebLogic* to its own *WebSphere* product. When compared to *.NET,* the price/performance ratio for the *J2EE* products seems unfavourable presently, at least according to the price comparisons and benchmarks presented at *Microsoft's .NET* web site http://www.gotdotnet.com/team/compare/default.aspx, partly confirmed by [Midd02a], discussed in [Loeb02], and criticised in [IBM02] and [Orac02] (cf. also [Midd02b-c]). More benchmark results are found at http://www.tpc.org. According to [Loeb02], the strength of the leading *Java*-based application servers will rather be their reputation for reliability, stability, security, and – with some provisos – portability. At http://www.objectwatch.com, incisive critical appraisals of many specific *J2EE* technologies are available. For a more cheerful view of these technologies as well as reviews of many *J2EE* products, see http://www.theserverside.com.

[417] *Entity beans* have been severely criticised by, for example, [Sess99a-e]. See also footnote 498 on p. 115 below.

1.7.4 THE SIGNIFICANCE OF *JAVABEANS*

Although, viewed as an attempt to create a market for visual *Java* components comparable to the already existing one for *ActiveX* components, *JavaBeans* hardly has been a spectacular success, it can by no means be dismissed as an insignificant or uninteresting piece of technology. Firstly, by facilitating component-based interface builder tools à la *Visual Basic* and the kind of middleware componentry pioneered by the *Microsoft Transaction Server,* it constitutes a crucial element in *Sun's* overriding strategy of offering a portable, "pure" *Java* environment that covers as completely as possible all the enterprise developer's needs. Without support for either, *Java* could hardly have been portrayed as a serious alternative to *Microsoft's* enterprise technologies. Secondly, *JavaBeans* provides an antithesis to the *COM* view of component-orientation as incompatible with "traditional" object-orientation, firmly re-establishing component-orientation inside the precincts of the object-oriented paradigm. Through the arrival of *Microsoft's .NET* this view of software componentry has in effect prevailed over the previous component-oriented separatism, which most probably will thus have been laid to rest once and for all.

1.8 SOFTWARE COMPONENTS IN COMPUTER SCIENCE RESEARCH

Although many of the seminal ideas behind the currently predominant software component technologies ultimately descend from academic research efforts and some of the leading architects of these technologies are academically schooled researchers, these technologies have certainly not been designed and developed in the academic milieu, nor have they been profoundly shaped by the highbrow research approaches and theories of computer science. Instead, today's software componentry spring from the somewhat middlebrow hacker cultures of the software *R & D* departments and laboratories of a few large companies in the computer business, such as *Microsoft* and *Sun,* or from industrial consortia, such as *OMG* and *CI Labs,* made up of such companies. Albeit by no means fighting shy of promising research results capable of being transformed into revenues and competitive advantages, these companies will in their component endeavours be primarily impelled by the trends and demands of the always mercurial and fervently competitive software market, their contenders' products, plans, activities, vapourings, schemes, and cabals – i.e. the almost proverbial "object and component wars" –, and other similar forces and factors.

Academic research in components still remains something of a novelty, a rather inchoate fringe phenomenon, although an impressive number of research workshops and a few conferences have been organised during the last few years and the research interest in the field seems to be rapidly increasing presently.[418] Not very surprisingly, the computer scientists, who have jumped on the new-fangled bandwagon of software component research, have tended to approach it from the point of view of the speciality in which they already work. Thus formal methods specialists tend to take a formal view of components, compiler theorists primarily are game to focus on the niceties of components as programming language constructs and of their proper implementation in such languages, software engineering people mostly consider components from a reuse, work process, or some other typical software engineering angle, modelling and design specialists look to the rôle of components in modelling and design, etc. As pointed out earlier, there is no consensus as to what is to be called a "component" across these different sub-communities, or even inside each of them.[419] Below, two leading – perhaps *the* two leading – "schools" in academic component research, viz. the compiler-oriented "Swiss school" and the software engineering-oriented "software architecture school", will be briefly attended to. Yet another direction, the "business object school", will be subject to scrutiny in a separate chapter.[420]

1.8.1.1 The Swiss School

Much of the current academic or academically tinged interest in components ultimately emanates from Niklaus Wirth's group at ETH in Zürich and the researchers involved in the development there of the programming language *Component Pascal,* formerly known as *Oberon.*[421] The leading figure in this group is Clemens Szyperski, the author of the book *Component Software. Beyond Object-Oriented Programming,* which has

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[418] Some relevant workshop and conference proceedings are [BCM95], [LS97], [Jell97], [Naho97], [Grun98], [Anon98c], [Anon98a], [Anon98b], [Anon99a], [Anon00a], [CSSW01], [CSSW02], [Anon99b], [GPF99], [DOV99], [DOV00], [LS01a], [CLS02], [DG02], [Bish02], [EG99], and [ET01]. Other relevant proceedings are referenced in footnote 133 on p. 32, footnote 425 on p. 98, and footnote 469 on p. 109. There will also be occasional pertinent papers presented at such conferences and symposia as *OOPSLA (Object-Oriented Programming Systems, Languages & Applications), ECOOP (European Conference on Object-Oriented Programming), OOIS (Object Oriented Information Systems), TOOLS (Technology of Object-Oriented Languages and Systems), USENIX COOTS (Conference on Object-Oriented Technologies and Systems), FOOL (Foundations of Object-Oriented Languages), JMLC (Joint Modular Languages Conference), EDOC (Enterprise Distributed Object Computing), DOA (Distributed Objects & Applications), DAIS (Distributed Applications and Interoperable Systems), Middleware, CAiSE (Conference on Advanced information Systems Engineering), COMPSAC (Computer Software and Applications Conference), ICSR (International Conference on Software Reuse), WICSA (Working IEEE/IFIP Conference on Software Architecture), ICSE (International Conference on Software Engineering),* and the *Euromicro Conference* (see http://www.idt.mdh.se/ecbse), or at workshops held in conjunction with these conferences. Even more workshops and conferences are listed at http://www.cetus-links.org/oo_distributed_objects.html. [Brow96a], [Anon00c], [LS00], [HC01], [DG01], [Aksi01], and [CL02] are anthologies of research papers or studies concerned with software components from a plethora of viewpoints. Additionally, issues of some popular computer magazines, such as, for example, the *Communications of the ACM* (October 2000, October 2002), *Software Development* (September 1998, May 1999), *Software – Concepts & Tools* (Vol. 19:1), *BYTE* (May 1994, January 1996, August 1997), *IEEE Software* (September/October 1998), or *Application Development Advisor* (March/April 1999, September/October 1999), may occasionally be specially devoted to software componentry. *Application Development Trends,* formerly *Component Strategies* (and *Object Magazine),* more regularly covers software component issues at some length (see also http://www.adtmag.com).

[419] See p. 28 et seqq. above. Cf. also p. 24 et seqq.

[420] See below p. 109 et seqq.

[421] See http://www.oberon.ch.

become something of the academic software component enthusiasts' bible.[422] This group of compiler specialists has framed an interesting critique of some aspects of the object-oriented paradigm – and in particular of implementation inheritance[423] – and advocates a component-oriented programming paradigm characterised by support for strong typing and a contractual view of components. Whereas they have been markedly critical of object-orientation and loath to take part in the current *Java* craze, they have been much more favourably affected towards *Microsoft* and its technological solutions than is customary in present-day computer science Academe.[424] They have also together with some other computer scientists, primarily people with a research interest either in compiler theory or in software engineering, organised the important *Workshop on Component-Oriented Programming (WCOP)* held yearly all since 1996 at the *ECOOP* conferences.[425]

1.8.1.2 Software Components and Software Architecture – Birds of a Different Feather?

The concepts of *software components* and *software engineering* both derive from the late 60s, or to be more specific from the momentous *NATO* conference in Garmisch in 1968. Albeit thus by no means a novelty to software engineering, *software components* are doubtless presently "in" amongst software engineering researchers and so is *software architecture,* another topic with a long history having grown increasingly "hot" during the last few years. *Prima facie,* it would seem that these two approaches to software design and development would fit hand in glove, software architecture providing the glove, as it were, and software components the hand, fleshing out the empty architectural casing with the digits, nails, knuckles, and bones of actual software. Indeed, in the literature on software architecture the word *component* abounds – *components* and *connectors* are the abstractions from which architectures are fitted together. The literature on software components is less eloquent about architectural issues, but whether implicitly or expressly couched, the architectural implications of the adoption of a software component technology are truly imperious.

On closer inspection, it appears that all *components* are not alike. As we have seen, *components,* as understood within the domain of *software engineering,* are very different from the *components* of commercial component technologies that primarily have concerned us in the previous sections. The former "components" would in the general case not even be accepted as bona-fide components within the contexts where the latter subsist. Although it is true that *component,* just like *object,* is a remarkably elastic term, the exact meaning of which depends upon the context and the speaker, there are clearly two distinct traditions of usage, each belonging to a particular subdomain of software construction. These two different understandings of components reflect an even more deep-seated cleft in outlook and mindset between the *software architecture* and the *software components* fields. This cleft cuts through most aspects of the two areas, including their origins, the producer/consumer communities formed around each, technical bases and biases, and the project, literature, and research styles favoured. Let us cast a quick glance at these differences.

Origins. Software engineering, software reuse, and *software architecture* as specialised fields of research all have their roots in large *U.S.* defence initiatives and their specific temper and character have been deeply influenced by this ancestry in various ways. The *Software Engineering Institute* at Carnegie-Mellon University in Pittsburgh[426], the omphalos of this complex, was once founded – and funded – by the *U.S. Department of Defense STARS (Software Technology for Adaptable, Reliable Systems)* programme. In contrast, the cradle of today's commercial *software component* technologies was the highly competitive personal computer market and, in particular, its own omphalos, *Microsoft.* Arguably, *Microsoft's* timely adoption of software componentry in the early 1990s in fact

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[422] [Szyp98a]. Other important representatives of the Swiss school are Cuno Pfister, the managing director and chairman of the board of *Oberon Microsystems,* Michael Franz of the University of California, Irvine, and Wolfgang Weck, a software architect at *Oberon Microsystems* and former lecturer at Åbo Akademi in Finland.

[423] See below p. 232.

[424] Tellingly, Clemens Szyperski, who formerly was a lecturer at Queensland University of Technology in Australia, is now affiliated to *Microsoft Research.* See http://www.research.microsoft.com/users/cszypers.

[425] The proceedings of the first five workshops (1996-2000) were published as [SP96] (see also [Mühl97] p. 125 et seqq.), [WBS97] (see also [BM98] p. 323 et seqq.), [WBS98] (see also [DB98b] p. 130 et seqq.), [BSW99a] (see also [BSW99b]), and [BSW00a] (see also [BSW00b]). The papers of the sixth and seventh workshop are found at http://research.microsoft.com/~cszypers/events/WCOP2001 (see also [BSW02]) and http://research.microsoft.com/~cszypers/events/WCOP2002, respectively.

[426] See http://www.sei.cmu.edu.

constituted the very lever by means of which the company was able to vault into its current pinnacle position on the *PC* software market.

Producers. Software architecture is primarily propelled by computer science academe, albeit admittedly in close co-operation with its mainly industrial consumers. In contrast, the frontiers of *software component technology* are advanced by the development groups and research laboratories of *Microsoft* and a few other computer companies, including *Sun* and *IBM,* or industrial consortia such as the *Object Management Group (OMG)*, and although some of the leading people involved, such as *Microsoft's* Anthony Williams and *SunSoft's* Gregory Hamilton, are indeed academically schooled researchers, they are neither pursuing an academic career, nor taking part in the rites of the software research community on a regular basis.

Consumers. Software architecture is primarily geared towards the large-scale manufacturing industry and, in particular, towards the defence industry and some other industrial sectors, such as telecommunications or avionics, where software and hardware are combined into highly complex and demanding technical systems. Its consumers are found inside a technology-oriented community of mainly well-educated engineers, although the majority of these will not be *computer* or *software* engineers. *Software component technology* is mainly popular in the two very diverse and constantly expanding domains where either *personal computers* or the *Internet* – or, more likely, both – are the main platforms of software. Generally speaking, these domains have a much more business-oriented flavour than the ones that constitute the mainstay of software architecture. Here, software artefacts are mostly *GUI*-oriented and commonly depend heavily on client/server database access. The consumers of the technology are also much more diverse than the clientele of software architecture and comprise both well-educated software experts and engineers and a large number of autodidact or little-educated programmers, and also some "power-users", who venture to dabble in the art of programming.

General outlook. From the difference in origins and producer/consumer communities follows very different goals and outlooks. *Software architecture* is primarily pursued by an academic research community, the prime goal of which is the publication of research results. The mindset of this community is characterised by a strong and sanguine scientism[427] and a predilection for abstraction, systematisation, fundamental principles, and formalisms,[428] and the tone of voice in its publications is fittingly serious and strict. Superficially, this can be taken to be *the* spirit of scientific research, but many other research communities well within the larger precincts of computer science[429] do not share these characteristics; rather, I think, this spirit is somehow related to the reliance on governmental and, in particular, military funding. In any case, all this is at a far remove from the mundane business goals and the spirit of incessant competition that are the drivers of commercial software component technology. This is an arena of alarums and excursions, where new rumours, hype, disinformation, ephemeral trends, corporate strategies, and phases of the "objects and component wars" are always brewing, while programmers, analysts, and various other software experts and pundits struggle hard to keep abreast with the latest technological advances and news from *Microsoft, Sun, IBM,* and *OMG*.

Literature. The literature on *software architecture* consists of a wealth of research papers and an increasing number of books.[430] In line with the software engineering heritage of this discipline, much of the literature has a strong feeling of handbook or of research paper compilation, or of both, about it. The predilection for abstraction, first principles and taxonomies and the serious, limpid and restrained style of writing typical of the *software architecture* literature have already been touched upon. In contrast, the huge literature on commercial

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[427] One particularly striking example is provided in [Shaw90].

[428] The descriptions of *architectural styles* in [SG96] p. 19 et seqq. and [BCK98] p. 93 et seqq. breathe heavily of this thin air of abstraction, taxonomy, and fundamental principles and may be contrasted to the much more down-to-earth character of the *architectural patterns* given in [BRMS+96]. The same variance in outlook sticks out in the treatment of *quality attributes* (also known as *non-functional requirements)* in [BCK98] and [BRMS+96] – in the former work these are looked upon as independent abstract principles, whereas in the latter they are closely related to concrete architectural solutions. *Software architecture* also shares a pre-occupation with the non-technical, organisational issues of programme development with some other branches of the tree of *software engineering*.

[429] For example, the boisterous human-computer interaction or design patterns communities are markedly different in character.

[430] Some influential recent books on software architecture are [SG96], [BCK98], [Hofm99], [Bosc00], [BRMS+96], and [SSRB00]. There are, or have been, a few specialised conferences and workshops on *software architecture,* such as the *Working IEEE/IFIP Conference on Software Architecture (WICSA),* the *International Software Architecture Workshop (ISAW),* the *International Workshop on Software Architectures for Product Families (IW-SAPF), and* the *Nordic Workshop on Software Architecture (NOSA),* but many papers on software architecture also appear at conferences on related topics, such as software engineering, object-orientation, software components, design patterns, etc., or in journals and magazines dealing with such topics. See also http://www.sei.cmu.edu/ata and http://www.wwisa.org.

software componentry is usually focused on very specific technical matters and issues, often down to the most excruciating level of detail, and its tone of voice is informal, not seldom tantalisingly jocose. To keep up with the developments in this area one must scavenge publications such as *MSDN Magazine, Dr. Dobb's Journal, Software Development, Windows Developer's Journal, JavaWorld, BYTE, Application Development Trends,* and *Application Development Advisor* rather than research journals and conference proceedings. In addition, *Microsoft's* and *Sun's* developer conferences and *OMG's* technical committee meetings are major events and crucial sources of information, supplementing the web sites and printed output of these companies and organisations.

Technology basis. The technical environments where *software architecture* and *software components* have caught on tend to be quite different as well. *Software architecture* is clearly geared towards the field of technical programming and technical systems – frequently embedded, real-time, highly reliable, or otherwise somewhat "exotic" or "complex" systems, or systems where specialised hardware plays an important part. *UNIX* and various real-time operating systems and languages such as *Ada, C, C++,* and *Java* typically constitute important parts of this picture. The realm of *software components* is largely that of *GUI*-based client/server systems, nowadays mostly seasoned with an *Internet* ingredient as well. As a technical platform, personal computers running some version of *Windows* are more or less taken for granted. Visual *RAD*-style languages, such as *Visual Basic, Delphi, Team Developer,* or *PowerBuilder,* are usually preferred for most business-oriented programming purposes, although *C, C++,* and *C#* are also popular, mainly for systems programming purposes, technically oriented development, or product development for the mass market, whereas *Java* has made some inroads as well, in particular in the rapidly expanding field of *Internet*-related programming.

Project style: The projects mainly borne in mind by the creators and adherents of *software architecture* will be the very large and long-ranging ones, i.e. the traditional domain of *software engineering* and *software reuse*. This is in contrast to the more informal, not to say chaotic, rapid solution style of typical component-based development efforts, where development times often are counted in months or, occasionally, only in weeks or days.

These differences identified, we may ask: Can birds of a different feather flock together? Is component-based software architecture in actuality an oxymoron? Or may *software components* and *software architecture* be felicitously combined, and, if so, which are the potential effects of synergy? We will look at these questions from two angles.

Firstly, does *software architecture* need *software components?* Software components have undoubtedly been winning ground apace during the last decade and have percolated into also the domains that traditionally have been the strongholds of *software engineering* and its subdisciplines, of which *software architecture* is a particularly prominent one. The first steps towards an adoption of this novel technology within the realms of software engineering were taken in the mid-90s, as witnessed by the appearance of a number of component-related publications from the *Software Engineering Institute (SEI)* and some other sources and the popularisation of the phrase *component-based software engineering* at this time.[431] The first forays into the domains of commercial software componentry chiefly concerned *OMG's CORBA,* probably because *CORBA* fitted the traditional technology biases of the software engineering community better than its competitors. As time went on, the range of interest was soon widened towards the *COM* and *Java* technologies as well.[432] Indeed, since component-based development has already become the predominant paradigm of programming in some very large domains and is rapidly making its way into others, it is peculiar that this interest has remained comparatively feeble.[433] In order to retain its industrial relevance and attraction, software architecture must, I contend, more wholeheartedly embrace today's commercial software component technologies and the programming paradigms they imply, which it needs to integrate fully with its current body of knowledge and theory.

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[431] [BCM95], [Brow96a], and [Aksi01] contain selections of relevant papers, and in [LS97] a few other such papers can be found. Cf. also [BCK98] p. 165 et seqq. Tellingly, *Component-Based Software Engineering* was the title of two different books, [Brow96a] and [Jell97], which appeared at this time. A third, more recent, handbook-like tome [HC01] is also so entitled, whereas *Component-Based Product Line Engineering with UML* is the title of [ABBK+02]. See also [Same97b], [Brow00], and [CL02].

[432] See, for example, [HC01], [CL02], and [WHS02]. See also http://www.sei.cmu.edu/cbs, the web page of the *COTS-Based Systems (CBS) Initiative* of the *Software Engineering Institute*.

[433] Links to a dozen research groups can be found at http://www.fuka.info.waseda.ac.jp/Project/CBSE/index.html.

Secondly, do *software components* need *software architecture?*[434] Many of the potential boons of software architecture are general in character and have neither more, nor less bearing on component-oriented than on non-component-oriented software development. It is, for example, hard to argue against the usefulness of architectural design, be it a component-based or a traditional monolith system that is under consideration. The *RAD* style of programming typical of component-based development will, however, be less inclined to meticulous analysis and design work and may often avoid the problems of "megaprojectosis" incumbent upon traditional monolithic efforts simply by shortening development times and shrinking project sizes down to the level of easy manageability.[435] Architectural design should in any case be integrated into the analysis and design methods in use and not be pursued in splendid isolation.

Furthermore, the use of a commercial component technology entails important architectural decisions that need to be correctly understood and heeded for software architecture to become useful within the context of this technology. What is needed, in addition to today's general accounts of software architecture, is, I believe, a set of specialised software architecture "cookbooks" geared towards particular component technologies, such as *COM, .NET, Java Beans,* or *CORBA*. The popular pattern style of describing architectures and designs will provide an excellent framework for such efforts, although other kinds of descriptions might be valuable as well.[436] This does not imply that architectural undertakings with a less precise scope are useless; on the contrary, these are needed to get an overview of the options at hand and as sources of inspiration.[437]

Apart from the overriding considerations put forward above, there are some more specific points where *software components* may take advantage of the concepts and ideas of *software architecture*. The notion present in some *Architecture Definition Languages (ADLs),* such as *Rapide,* of a plug-and-socket architecture, where not only operations exposed by a component, but also operations called from inside the component are part of its interface, will, for instance, be useful to software components as well.[438] This notion has in fact been integrated into the *CORBA Component Model* through its "receptacles", as recounted above.[439] Additionally, *ADLs* come very close to such component specification languages as the *Component Definition Language (CDL)* proposed for adoption within the *Object Management Group* some years ago[440] and the *Component Interface Definition Language (CIDL)* that is part of the new *CORBA Component Model* specification.[441]

Will our birds of a different feather eventually flock together? As indicated by the above musings, it is reasonable to believe that they both will and must and, indeed, already have started to coalesce, although one might be inclined to predict that considerable pecking will take place within the somewhat motley flock that will result and that some moulting may be needed in order to harmonise its disparate members.

1.8.2 A CONCLUDING REMARK

Despite the alluring rhetoric about "open processes", the very nature of today's software component technologies as forbiddingly complex key elements in a few – today in reality two – behemoth computing

[434] To answer this question we need some intuitions about what the domain of software architecture is. Firstly, there are a number of core elements, including at least 1) miscellaneous notations, formalisms, and *Architecture Definition Languages (ADLs),* 2) a "system" of architectural styles, and 3) a few architectural design and review methods. Secondly, there are various related technologies that have, however, mainly originated and evolved outside the software architecture camp. These include, for example, frameworks, architecture patterns, and various *domain-specific software architectures (DSSAs)* – as well as the very theme of this chapter, the notion of *software components*.

[435] See footnote 71 on p. 19 above.

[436] [MM97] is a patterns-based treatment of *CORBA* and [Mari02] of *Enterprise JavaBeans*, whereas [BBC01] provides both architectural and design patterns for *COM+*. See also [ABBK+02] p. 199 et seqq. [Sims94], Oliver Sims' seminal work on *business objects,* contains an extensive treatment of client/server architectural issues. Cf. also [AF98] p. 17 et seqq.

[437] The *Lotus' InfoBus* (see [Cola99]) intended for easy interconnection of *Java Beans* and *Java* applets illustrates how useful ideas may flow between very different domains of application – *software buses* were initially intended for the interconnection of applications that were parts of a software development environment (see [Reis90]). Cf. also [Beac92] and [PA91].

[438] See [LV95] and [LVM95]. Cf. also [OB97].

[439] See p. 82 above.

[440] [DENS+98a-b]

[441] See [OMG02b] and [Sieg00] p. 114 et seqq.

companies' overriding infrastructural strategies makes it extremely difficult for researchers to make a perceptible impact on the development of the technology *per se,* at least in the short run, if they do not choose to work directly with *Microsoft, Sun,* or, perhaps, *OMG*. Thus, technically oriented academic researchers, only rarely having a toehold in these organisations, will largely have to content themselves with producing reviews, aperçus, criticisms, and proposals about already existing technologies. In contrast, the software engineering and architecture perspective will more easily prove itself useful by focusing on how to *utilise* the technology at hand in the best way. Nevertheless, I will myself in this study rather venture to pursue the former path than the latter, reconsidering and analysing the idea of software componentry as well as its technical shape from various points of view and trying to propose useful refinements, alterations, and re-combinations. In particular, I will focus on and try to develop the concept of "business objects", construed as a kind of object-oriented, very large-grained, independently executable components, which correspond directly to things in the real world and interact with each other through semantically tagged messages. Albeit currently somewhat out of vogue, such business objects may, however, become important in the future for a number of reasons, to which I will come back below.

1.9 SOME FINAL REMARKS AND REFLECTIONS

Below I will gather together a few, admittedly somewhat disparate, reflections and *obiter dicta* I have made on today's software componentry during my own work in the field. Firstly, I will consider the popular fascination with comparisons of different component technologies and how this genre of writing has developed over time. I will then try to identify some success factors for component technologies, before I finally round off the chapter by briefly examining the too often neglected dark sides of software componentry.

1.9.1 COMPARING COMPONENTS

> *All this CORBA/OpenDoc versus COM/OLE stuff can really be confusing.*
>
> *"Zog the Martian" (1996)*[442]
>
> *The battle lines are clear: It's .NET versus the Java world.*
>
> *David Chappell (2002)*[443]

In the mid-90s, when the "object and components wars" were at their zenith, comparisons of component and distributed object technologies abounded in computer magazines, on the *Internet,* and in the software component literature. However, the juxtaposed technologies shifted over time: *COM* vs. *SOM*[444]*, OLE* vs. *OpenDoc*[445]*, COM/DCOM/ActiveX* vs. *CORBA*[446]*, RMI* vs. *CORBA*[447]*, ActiveX* vs. *JavaBeans*[448]*,* and *MTS/COM+* vs. *Enterprise JavaBeans*[449] were pairs of technologies often contrasted, although there were also other possible variations on the theme.[450] Most of these comparisons espouse a kind of dualistic outlook, where some piece of *Microsoft* technology is pitted against some other technology, deemed as alternative to it. This dualistic ethos, of course, mirrors the competitive nature of the marketplace, where the "component and object wars" are part of a larger struggle for market and mind share between *Microsoft* and a number of other important computer and software companies such as *Sun, IBM, Oracle, Netscape,* and *Apple.* Whereas the first part of this "war" was primarily waged on the desktop *(COM* vs. *SOM, OLE* vs. *OpenDoc),* the second phase has rather concerned server platforms, middleware, and the *Internet (DCOM/ActiveX/COM+* vs. *CORBA* vs. *RMI/JavaBeans/Enterprise JavaBeans).* In its most recent embodiment, the combatants of the struggle will, as David Chappell succinctly pointed out in the epigraph, be *.NET* and the *Java* world, presenting the market with a choice between a multiple language, single platform and a single language, multiple platform philosophy.[451]

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442 [OHE96b] p. v

443 [Chap02] p. 120

444 See [IBM94b] and [Box].

445 See [IBM94a].

446 See [WSB97], [Micr97c], [Chap97a], [CHYL+98], [Carr97], [OH97b] p. 287 et seqq., and [Prit99].

447 See [Curt97] and [OH97b] p. 239 et seqq.

448 See [PM97].

449 [Sess98b], [Sess99a-e], [RÖ99a-b], (cf. also [Sess00a] and [Roma00]), [RSH99], [Chap98d], [Micr98l], [Viza98], and [Lint99] pit *MTS* (or *COM* or *DNA)* against *Enterprise JavaBeans* (and *CORBA).*

450 For instance, *COM/OLE* and *CORBA/OpenDoc* are contrasted in [OHE96b] p. 535 et seqq., *CORBA/IIOP, DCOM, RMI, HTTP/CGI,* and sockets are compared in [OH97b] p. 331 et seqq., *CORBA/OMA, DCOM/OLE/ActiveX,* and *Java/JavaBeans* (and *Texas Instruments Composer, Netscape ONE,* and *IBM Visual Age* and *ComponentBroker)* in [Szyp98a] p. 169 et seqq., *COM* and *JavaBeans+CORBA* in [Szyp98b], *DCOM, CORBA,* and *RMI* in [Jaco98], *CORBA Components* and *Enterprise JavaBeans* in [Hube99], *ActiveX/(D)COM, JavaBeans/Java Studio Components, CORBA/BOF,* and *Voyager* in [Grif98] p. 77 et seqq., *CORBA, COM,* and *Java/RMI* in [Emme00] p. 87 et seqq., *COM+, EJB,* and *CCM* in [Long01], *JavaBeans, COM+, CCM, .NET,* and the *Open Service Gateway Initiative (OSGI)* in [EF02], and *Java servlets* and *EJBs* in [BBD02].

451 For example, [Farl00], [VR01], [Sess01a], [LB02], [Lyki02], and [Loeb02] pit these two platforms against each other.

The purpose of the technology comparisons is as diverse as their scope and may, somewhat arbitrarily, be compartmentalised in this way:

- *Polemical comparisons.* Some comparisons are – more or less frankly – polemical or promotional, attempting to show why one technology or other is superior to its main competitor(s).[452] Such items of writing are frequently published under a company name, often lacking any explicit statement of the author's name, and are, in any case, mostly written by people working for or being closely affiliated to the company or organisation that developed the technology advertised as superior – although exceptions do exist. In spite of their apologetic and, at times, somewhat high-pitched tone of voice, these pieces of promotional argumentation are often both well-argued and well-written and may be quite valuable for making the issues at hand as well as any deficiencies of the competitor's approach stand out in a clear-cut manner.

- *"Independent" evaluations.* Evaluations of technology performed by independent analysts or analysis firms form a second group. Earlier, I referred to one such report from *Ovum* in 1997 on object request brokers, which drew some quite controversial conclusions about the lack of future for *CORBA ORBs.*[453] Although such evaluations purport to help potential customers to choose a technology from some kind of neutral ground, no such "independent" analyst will in reality be completely free from commitments. For one thing, experts naturally tend to become enamoured with the technology that they consider their own primary domain of expertise.[454]

- *Surveys.* Another category consists of surveys of component technology in computer magazines[455] or component literature[456], almost inevitably including some kind of comparison between the main contenders of the area. These surveys generally tend to be somewhat less dedicated to the task of selecting a "best choice" than the writings of the aforementioned categories, but rather aim at elucidating and contrasting the various design choices made in the competing technologies.

- *Research papers.* Eventually, there are a few pieces of work couched in the style of research papers.[457]

I will not here attempt to accomplish any grand comparison of my own, which, considering the complexities of these technologies as described above, will be quite a daunting task, in particular if it is to transcend the narrow compass of a purely theoretical exercise by including realistic implementation experiments, tests, and benchmarks.[458] Although it is often instructive to make such comparative evaluations and tests of

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452 Examples include [IBM94b], [Box] *(SOM* vs. *COM),* [WSB97], [Micr97c], [Chap97a] *(COM/ActiveX* vs. *CORBA),* [IBM94a] *(OpenDoc* vs. *OLE).* The comparisons found in [OHE96b] and [OH97b] also arguably belong here, considering their authors' affiliations and clearly stated sympathies for the *CORBA* camp. The *Got Dot Net* web site hosted by *Microsoft* includes comparisons between *.NET* and *J2EE* (see http://www.gotdotnet.com/team/compare/default.aspx); the *Sun/Java* point of view is put forth in, for example, [Farl00], [VR01] (cf. also [IBM02], [Orac02], and [Midd02a-c]).

453 This expensive piece of writing was summarised in [Rock97a] and [Rock97b]. Heated retorts followed, such as [OMG97i], [Wels97a], and [Wels97b], trying to undermine the validity of the conclusions mainly by pointing out factual errors and outdated snippets of information in the report.

454 For instance, few cognoscenti will be taken aback by Roger Session's and David Chappell's praise of *Microsoft* technologies or by Ed Roman's eulogies on their *Java* counterparts. Nonetheless, these high-profile analysts' viewpoints and criticisms are mostly well-grounded and highly adequate due to their deep knowledge of the technology and sense for the realities that guide the business world.

455 [Betz94], [Adle95], [Wayn94], [Udel94a], [OH95b], [Lint96], [Pfis95b], [PM97], and [Lyki02] belong to this group.

456 The still forthcoming [Pfis97b] was supposed to contain a lengthy comparison of the most important technologies around. [OHE96b], [OH97b], [Prit99], [Szyp98a], [Grif98], [HC01], and [CL02] already do.

457 [CHYL+98], [Szyp98b], [EK01], [EK02], and [Kati95] may be pigeonholed as such. [Jaco98] is a M.Sc. thesis comparing *DCOM, CORBA,* and *RMI.*

458 In the kind of study pursued here, a full-scale comparison of, say, *.NET* and *Java 2 EE,* would, I contend, in any case be a work of supererogation, although I in [Pers97] p. 46 et seqq. included a table, in which the *Microsoft* and *OMG* technologies were contrasted on a number of counts. Similar rosters, which I also drew on there, are available in [Pfis97b], [OHE96b], and many of the articles referenced above.

concrete technologies, the relevance and value of their outcome will mostly be extremely ephemeral and even when fresh somewhat moot, insofar as most companies and organisations will in their choice of technology be guided by long-ranging commitments and strategies rather than the range of features and the performance the respective technologies can supply at a certain moment in time. The forbidding costs of changing such a strategy will mostly be avoided, unless there are absolutely compelling reasons to do so.

1.9.2 COMPONENT SUCCESS FACTORS

What are the pre-conditions necessary for the success of a component technology? Firstly, it should be emphasised that there are degrees of success. *C* and *UNIX* standard function libraries, *FORTRAN* numerical subroutine packages, or *Microsoft's COM* and *ActiveX* components have all been very successful in promoting reuse and productivity, but still their success has been basically *evolutionary,* rather than *revolutionary*. Although providing useful vehicles of reuse, these technologies have not dispelled "the software crisis" or created effects comparable to those of the industrial revolution, such as the formation of the production chains said to be typical of mature areas of industry and engineering.

For a component technology to be successful in the modest, *evolutionary* sense, five critical concerns must, I believe, be addressed:

- *Standardised component shape.* For a component to be useful in multiple contexts, it must adhere to some kind of component standard that defines its overall *shape*. "Standards" are here to be understood in a broad sense, which includes also industrial and *de facto* standards.

- *Standardised interfaces.* Components implementing well-documented standard interfaces are generally much more useful than custom-made components. The *C* standard libraries and the *Java* and *.NET* frameworks as well as the *COM/OLE/ActiveX* "prototypes" provide such interface definitions for various purposes.

- *Large domain of relevance and marketplace clout of backers-up.* A component technology will not be prosperous, unless its domain of usage and its backers-up are as well. As illustrated by the failure of the *OpenDoc* technology, it is a moot question whether there are any companies or organisations today besides *Microsoft* that have the clout to create such a component marketplace. Although arguably *Internet* and *Java* programming might seem to provide a domain large enough to support a sizeable *JavaBeans* market, this has hardly materialised as yet.

- *Simplicity.* Components should not demand too high a level of sophistication of their *users,* although considerable programming skills may be needed to *build* a component.

- *Language-independence.* The programming language arena has always been fragmented and susceptible to rapid changes of fashion, and for a component technology to become widespread and durable, it should probably avoid language isolation. This does not imply that it cannot have a primary target language – *C* function libraries indeed target *C,* and *COM* components have a *C++* bias, but both provide or at least do not exclude accessibility from a wide range of other languages.

None of the above concerns is technical in nature, and one may be inclined to conclude that the technical *shape* of components is orthogonal to the success of component technologies. The understanding of what the *right shape* for a component is changes over time, although for commercial success one must never swim in the backwaters, let alone be too much ahead of the current wave.

For software component technology to have the *revolutionary* impact widely held to be its ultimate objective and true attraction, yet another and more difficult issue must be addressed in addition to the aforementioned requirements for *evolutionary* success:

- *Payment mechanisms.* If component providers cannot sustain themselves by their trade, no thriving component marketplace will emerge. As forcefully argued by Brad Cox, the lack of

revenue collection mechanisms for binary goods effectively obviates the advent of component production chains and, hence, a more "industrial" style of fabrication of software.[459]

Whereas the five requirements for *evolutionary* success will be widely recognised, although seldom printed out in clear, strangely little heed has been paid to the conundrum of rational payment mechanisms for components – in spite of its pre-eminent significance and the exuberant potential benefits to be gained from its solution.[460] Since a resolution would probably require either global legislative measures or initiatives from major market players like *Microsoft, Intel,* and *IBM* and since there is currently no sign of either*,* we may safely predict that the flood of books and articles setting out with a reference to the "elusive goal of reuse" proposed by McIlroy in a shadowy past will for the foreseeable future continue to inundate the swampy fields of software construction.

1.9.3 THE DARK SIDES OF COMPONENTS

Although software components are often rather unreservedly eulogised and believed by many to be *the* antidote to the old spook of the "software crisis", there is certainly also a dark side of componentry, which has not been so widely discussed. Here I will only suggest some problem areas:[461]

- *Lacking payment mechanisms.* The difficulty to attain break-even for component producers was commented upon in the previous section.

- *Mismatch.* Very often a pre-made software component only fits a need imperfectly, presenting its potential user with the stark choice of either embarking upon the costly development of a custom-made component or accepting a component as it is and thereby compromising the usability of his own programme.

- *Quality.* A mass-produced product put together from pre-fabricated parts and targeting a large group of consumers will only seldom fill the needs of its buyer as well as a bespoke, carefully crafted, custom-made artefact. This is of course true for many kinds of component-made products, be it a pre-fabricated house, a ready-made suit, or a shrink-wrapped computer application.

- *Versioning.* Since different products installed on a computer may need different versions of the same component, conflicting demands may occur. Thus, software componentry needs an operating system that supports the parallel use of different versions of components.[462]

- *Class fragility.* Object-oriented components are liable to various class fragility and other issues, which will be examined at some length below.[463] Component types that do not support implementation inheritance, such as *COM* components or *C* function libraries are indemnified from these fragility problems.

- *Difficult debugging.* When components are used, debugging is exacerbated through the difficulty of knowing whether a certain bug is to be attributed to a component or to a mistake in the programmer's own code. As the programmer is not supposed to have access to the source code of the component, it may be impossible for him to track down and correct the bug, if it indeed resides in the component. There is also a nasty "ripple effect", by which the

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[459] See above p. 36.

[460] Even Szyperski, in his excellent book on component software, advertised as "an attempt at a unique merger of technology and market aspects driving component software" ([Szyp98a] p. 345), contents himself with a terse and sketchy treatment of this crucial subject matter ([Szyp98a] p. 339 et seqq.).

[461] Some more issues are identified in [Crnk01]. Cf. also [Kara98d] and [Hugh98].

[462] In *Microsoft's .NET,* this problem, haunting the use of *COM* and *ActiveX* components, has been reasonably addressed.

[463] See p. 232 et seqq.

bugs and changes introduced in a new version of a component will affect *all* applications that make use of the component in question.

- *Difficult testing.* Since the programmer does not know the inner design of the component, it may be difficult for him to identify the "weak spots" in need to be particularly well tested.

- *Bulk.* Since components are supposed to be self-contained, everything needs to be included in each component, which may cause programmes to become unnecessarily bulky and slow.[464]

- *Lack of interoperability.* It will be very difficult to achieve co-operation between independently manufactured components without extensive 'gluing', if not the most meticulous standardisation of all kinds of component interfaces has been undertaken first. In fact, most components only support minimal co-operation with a container according to strict rules laid down by the component standard complied with *(ActiveX, JavaBeans,* etc.)

For some of the above problems, such as the versioning issue, remedies have been or are about to be worked out, whereas others will be principal difficulties, much harder to address adequately. A few of them will also be revisited at somewhat more length below. Most certainly, they will provide researchers and developers in the field of software componentry, in industry as well as in academe, with worthy challenges for many years to come.

[464] See [Schm99] p. 135 et seq.

1 BUSINESS OBJECTS

During the last decade, the term *"business objects"* gained some currency as a watchword and a topic of discussion and study, largely in the wake of the *BPR (Business Process Reengineering)* movement of the early 90s.[465] It was encountered in the headlines and front pages of popular computer magazines[466], in several book titles[467], on a large number of web pages[468], and in the name of an *OOPSLA* workshop[469]. For some years, the *Business Object Domain Task Force (BODTF),* a committee operating within the *Object Management Group (OMG),* worked on an ambitious architectural framework for *business objects* – as well as on a number of related tasks.[470] After considerable altercation, the summer of 1998, however, saw the sad dénouement of the core *BODTF* effort into nothing.[471] Although this undoubtedly was a major setback that cooled down the temperature of the field greatly, work on *business objects* continued for some time under the auspices of the *domain task forces* and *special interest groups* of *OMG* as well as in various other fora, such as the Japanese *Consortium for Business Object Promotion (CBOP),* the *Open Applications Group (OAG),* the *European Union ESPRIT* programme *OBOE (Open Business Object Environment),* and the *Interoperability & Business Objects (IBO)* project pursued by the *Petrotechnical*

[465] One of the earliest users and possibly the most influential early booster of the term *business object* is Robert Shelton, who in 1993 proposed the organisation of a *Business Object Management Special Interest Group (BOMSIG)* to the *Object Management Group (OMG,* see [OMG93]). Who is to be credited with the coinage of the term is, however, not obvious. The web page http://www.openeng.com/library.html, albeit now removed, held a comprehensive list of Shelton's articles. On this list, the oldest item cited was an article catalogued as *Business Objects -- Starting it All Off,* allegedly published in the 1990 December issue of *Hotline on Object Oriented Technology.* I have not had the opportunity to flick through the pages of the *Hotline* myself, but according to the librarians of the United States *Library of Congress* there is no article by Shelton in the issue in question, and neither Shelton, nor *SIGS,* the publisher of the *Hotline,* has upon request been able to provide me with a copy of it. In fact, a search of some abstract databases, such as *INSPEC,* reveals at least two earlier instances of the term. In [Zloo83], Zloof, the originator of the *QBE (Query-By-Example)* database query tool, describes *OBE (Office Procedures By Example* or *Office-By-Example),* a superset of the *QBE* language, intended for "the automation of office and business applications" by enabling users to directly programme "two-dimensional business objects such as Tables, Forms, Reports, Charts, and Audio Documents", also referred to as "generalized data objects" in the paper. A similar usage can be found in [WM90], an account of the *HIBOL-2* visual programming environment developed at the University of Klagenfurt in Austria during the late 80s. This understanding of a "business object" as a programmable visible object in a visual programming environment is, however, quite different from the current usage. Aside from Shelton's shadowy *Hotline* article, the earliest published instances hereof I have been able to spot are found in [Gess92], a paper authored by Prof. Gessford of the *California State University* at Long Beach, and in Oliver Sims' writings from 1992 in *The SAA and Open Software Spectrum* and *OTM Spectrum Report,* the forerunners of the current *MiddlewareSpectra* reports. According to [HS00], the term "business objects" has been used "at least since 1991".

[466] For example, the cover stories of three issues of *Object Magazine* (January 1997, November 1997, and May 1998) involved *business objects.* In the mid-90s, columns on business objects were run in *Report on Object Analysis & Design* (authored by Gerald Kristen, see [Kris95a-c] and [Kris96]), *Object Magazine* (authored by Ted Shelton and David Taylor, see [Shel95o-p], [Shel96d], [Tayl95b-c], and [Tayl96a-b]), *Object Expert* (authored by Oliver Sims, see [Sims95b], [Sims96b], [Sims96d-g] [Sims97]), and *Data Management Review* (authored by Robert Shelton, see [Shel94a-b], [Shel95a-c], [Shel95f-g], [Shel95i-k], [Shel95m], and [Shel96a-c]).

[467] *"Business objects"* is part of the title of [SLJR94], [Sims94], [Prin96], [Fing96], [Part96], [Lhot97], [Lhot98], [ES98], [Carm98], and [Jack98]. [Gess97] is a textbook, [Merk96] a M.Sc., [Hung99] and [Chou99] Ph.D. theses on *business objects.*

[468] At http://www.cetus-links.org/oo_business_objects.html can be found a lengthy section of the *Cetus* collection of object-oriented web links devoted exclusively to *business objects.*

[469] The *OOPSLA Business Object Design and Implementation* workshop was arranged for the first time in 1995 and hereupon was arranged on another five occasions. The proceedings of the first workshop appeared in print as [SPCH+97] and were also made available on the web at http://jeffsutherland.org/oopsla/oo95wrkf.html. See also [Suth95c]. The proceedings of the subsequent workshops are also available on Jeff Sutherland's object web site, at http://jeffsutherland.org/oopsla96/index.html, http://jeffsutherland.org/oopsla97/index.html, and http://jeffsutherland.org/oopsla98/oopsla98.html, respectively. A selection of papers from the 96-98 workshops was printed as [PSM98]. The papers from the 1999 workshop are available at http://jeffsutherland.org/oopsla99/index.html and in the workshop proceedings [PSM99], whereas the papers from the sixth workshop are available only at http://jeffsutherland.com/oopsla2000/index.html. Sessions on business objects have been part of some other workshops and conferences, such as *EDOC'98, EDOC'99 (EDOC = Enterprise Distributed Object Computing),* and *NOSA'99 (NOSA = Nordic Workshop on Software Architecture).* See [EDOC98], [EDOC99], and [Bosc99].

[470] Its documents can be found at http://cgi.omg.org/cgi-bin/doc?bom and http://ftp.omg.org/docs/bom, if one knows the document number.

[471] *BODTF* seems to have been operative into early 2001 – the last document in the *OMG* document group */bom* is [Casa01], which dates from March 2001 –, although its purview of interest and tasks was much reduced after the 1998 debacle. It still has a web page http://www.omg.org/homepages/bodtf/index.htm. In addition, the *Business Objects Initiative (BOI),* which was organised upon the failure of the business object effort, but apparently is no longer active (see http://www.omg.org/homepages/boi), and the currently more sprightly *Business Enterprise Integration DTF* (see http://bei.omg.org) partly address the same problem area as *BODTF.* See p. 177 et seqq. below for more details.

Open Software Corporation (POSC).[472] A largish software company in the database and data warehousing tools business has adopted the name *Business Objects, Inc.,* although the rationale for this choice of name is not altogether translucent.[473] Additionally, in the object-oriented strategy of *SAP (Systems, Applications, and Products in Data Processing) AG,* the provider of the popular *R/3* package of *ERP (Enterprise Resource Planning)* software, *business objects* played an important rôle for a time.[474] Among the plethora of object-oriented methods suggested over the years, there is also a *Business Object Notation (BON)*[475], and in most object-oriented methods the idea of *business objects* plays an important rôle, although this term may not always be the one used. According to a poll made at the *OOPSLA '97* conference, 72% of the respondents had heard tell of *business objects,* and 39% actually used *business objects* in their own organisations.[476]

In the literature, some remarkable claims have been made about *business objects,* bespeaking a vision of these as a future mainstay of software construction – or, perhaps rather, of software assembly –, "the next step in component technology"[477]. For example, Orfali, Harkey, and Edwards flamboyantly state:[478]

> *The ultimate goal is to let you create components that behave like business objects. These are components that model their real-world counterparts in some application-level domain. … So the ultimate Nirvana in the client/server components business are supersmart business object components that do more than just interoperate–they collaborate at the semantic level to get a job done.*

Providing some more meat on the bones, Oliver Sims, who has been called "the father of today's business object movement",[479] summarises his ideas thus:[480]

> *Our aim is to create a new vision of computing. This vision is of distributed business objects existing as independently developed executables or binaries, which can be deployed and re-deployed as self-contained units anywhere in the network, and on any platform. These business objects interact freely –as peers– to meet users' needs. The business object vision includes:*
>
> - *ad-hoc integration of business objects by end-users–without necessarily involving developers;*
> - *one-to-one mapping between object models and designs on one hand, and the binaries–the units of delivery–produced by developers on the other;*
> - *simple customization (by subclassing) of binaries;*

[472] For further information, see http://www.cbop.gr.jp, http://www.openapplications.org, http://www.opengroup.org/public/oboe, and http://posc.org/technical/interop. *OAGIS (Open Applications Group Integration Specification)* supports application integration through *XML*-based *Business Object Documents (BODs).* See [OAG00], the version 6.2 of the *OAGIS* design document, of which the latest version (currently 8.0) can be purchased at http://www.openapplications.org/oagis. Cf. also [OAG99], [SLML+00], and [LS01b]. There are, of course, many other initiatives aiming at the standardisation of message semantics or of call interfaces, such as the *COM/OLE* domain initiatives supported by *Microsoft.* See p. 568 and footnote 2470 on p. 538 below.

[473] See http://www.businessobjects.com. Cf. also [Jack98].

[474] See [SAP97]. Cf. also http://www.sap.com/solutions/technology/index.htm.

[475] See [WN95] and [Paig99]. Cf. also [PO98] and [PO99a-b].

[476] See [HSR98] and [Hung99] p. 47 et seqq. Of 1500 questionnaires distributed at the conference, 201 were returned. As for the issue of representativeness, a poll made at an *OOPSLA* conference only reflects the statements made by the *OOPSLA* conference participants who care to turn in a particular questionnaire – and nothing else.

[477] [EE98c]. Cf. also [Grif98] p. 22 et seqq.

[478] [OHE96b] p. 38.

[479] [Bake97a]

[480] [Sims96c]

> - *ability for IT-shop business solution developers to create, as well as use, the business objects;*
> - *objects as things, which are just like real-world things. That is, they can be handled and moved around independently without necessarily having to return them first to their builders for re-integration.*
>
> *This vision is much more than a software component vision. It is a vision where the end products of software development are directly useful to end users as things in their own right, just as phones, desks, cars, notepads, pens, and so forth, are directly useful. In particular, just like real-world things, business objects should be able to be used together in ways that were unplanned by their developers–if a user finds it effective to do so.*

Robert Prins, the author of a book on business objects, takes a similar view:[481]

> *The future information system will take the form of a swarm of business objects that are event driven, concurrently executing and running in a distributed and often heterogeneous environment—business objects that engage each other in numerous patterns of collaborations.*

In his lucid and liked object technology guide for managers, David Taylor alludes to this vision of business objects and deplores the current lack of realisations of it:[482]

> *At the same time, object technology has failed to deliver on some of its most exciting promises. The much anticipated market for pluggable business objects has yet to materialize, and most companies are still grinding out applications line by line rather than assembling software from prebuilt components.*

Speaking of the invention of the *Internet, TCP/IP*, and hypertext, Jeff Sutherland, the chief organiser of the *OOPSLA* business object workshops, points out business objects as one of the "mutations" needed for a new computing paradigm to emerge:[483]

> *By the time these technologies had incubated for 20 years, it was evident in the early 1990's that the major thrust of computer-human interaction approaching the millenium was the use of hypermedia systems to augment the human mind, much as the telescope and microscope had augmented human vision… All that remained were the triggering mutations required to cause an evolutionary explosion of distributed object-oriented, graphical, hypermedia systems on the Internet. These mutations occurred in 1993. They were the Web browser, Java, the first computer language designed for dynamic distributed objects on the Web, and Business Objects, an approach to reengineering distributed software applications to support global reengineering of corporate organizations.*

If business objects indeed bid fair to become a cornerstone of tomorrow's software environments, as the above quotations may indicate, it may be worthwhile to ask:

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481 [Prin96] p. 19

482 [Tayl98a] p. xiv

483 [Suth97a]

- What more exactly does the term "business object" signify?
- Why are extraordinary expectations harboured by some about these *"business objects"* and how are the claims made supported?
- What *business objects* implementations and technologies exist or are in gestation currently?
- What is the relation of business objects to current object and software component technologies and in particular to commercial component technologies such as *COM/OLE/ActiveX, JavaBeans,* and *CORBA/OpenDoc?*

The sections to follow will delve into these questions and attempt to give some tentative answers. As we shall see, the polyannic expectations attached to *business objects* by some enthusiasts were never really made good, but the field largely remained stuck in a rather immature and visionary stage, where a great number of more or less enticing ideas and proposals were battered around, while actual implementations and first-hand experiences remained scarce and incomplete, at least as far as the more advanced features and infrastructural underpinnings were concerned.[484] As a consequence, many accounts of *business objects* lacked the level of concretion and technical detail required for real practical usefulness, although there is no denying that the potential benefits of some of the suggested avenues indeed were substantial. Additionally, those *business objects* systems that did exist did not always match the rhetoric of some of the proponents of the field, to put it charitably.

[484] [PW94], [Wood95], [Clea96], [HN97], [Estr98], [HMPS98], [HMSP+00], and [TK00] report various experiences from attempts to take advantage of *business objects* in practice. See also http://www.oig.co.uk/ObjectInterestGroup.html, the web site of the *Object Interest Group (OIG).*

1.1 BUSINESS OBJECTS – SHIBBOLETH OF MANY MEANINGS

Just like *component, object,* or *agent, business object* is one of those popular buzzwords that annoyingly often are used quite vaguely. Moreover, while the use of the epithet *business* may exercise an irresistible allure on some of us, it may surely appear suspect or even give umbrage to others. Partly to relieve the reader and ourselves of any such terminological chagrin, partly, and more significantly, to investigate the *ontology* of *business objects,* i.e. what it essentially means to *be* a *business object,* a number of senses commonly imputed to the term will be disambiguated below.[485] These are indeed not exclusive, but are habitually blended more or less implicitly in all kinds of motleys and mixtures.[486]

1) *The "business domain object" interpretation.* The most straightforward way of understanding the term *business objects* is as a designation for objects that represent "business concepts", i.e. concepts, things, people, etc., which one comes across in the world of "business". Notably, the *"business domain object"* interpretation is the gist of the *BOMSIG* definition of *business objects* often quoted in documents that emanate from the *Business Object Domain Task Force (BODTF)* of *OMG:*[487]

> *A representation of a thing active in the business domain, including at least its business name*[488] *and definition, attributes, behavior, relationships and constraints. A business object may represent, for example, a person, place or concept. The representation may be in a natural language, a modeling language, or a programming language.*

2) *The "real-world object" interpretation.* Frequently, the scope of *business objects* is not restricted to the business domain – whatever its confines may be –, but any object having a real-world counterpart is referred to as a *business object.*[489] Such *business objects* are often contrasted to *system objects* or *technology objects,* i.e. objects without a real-world connotation, used solely for technical purposes in the implementation of a system.[490] *Business objects* in the real-world sense may be partitioned into *domain objects,* which are specific to a certain domain, and *common business objects,* which are common to multiple domains. One example of the real-world interpretation can be found in the *Dictionary of Object Technology:*[491]

> ***business object*** *n. any object that models some essential aspect of the application domain.*

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485 It should be noted that our usage of the word "ontology" chimes with that of philosophy and phenomenology rather than with that of computer science and AI research.

486 A quite different list of the meanings of *business object* is given in [Hung96] p. 2; cf. [Hung99] p. 43 et seqq. [ES98] p. 5 et seqq. and [HS98a] meritoriously try to clarify the different meanings of the term *business object* contextually and to reduce the overloading the term suffers from as well. Cf. also [OMG97s], where a distinction is made between "modeling business objects" and "systems business objects", which correspond to our *analysis objects* and *business domain objects,* respectively.

487 [OMG95e]

488 The same document defines business name "as a property of a business object, the term used by business experts to classify a business object".

489 If only concrete real-world entities, organisational units, and the like, or also other kinds of real-world concepts qualify as *business objects,* is moot. [OMG97s] distinguishes three kinds of *business objects*, viz. *entity, process,* and *event* objects. [SBM96] argues that *processes,* being equivalent to workflows, are not *business objects*. Cf. below p. 132, [SS98a], and [EP00] p. 378.

490 [Lhot97] p. 25 et seqq. contrasts business objects (in the "real-world object" sense) with *user interface* and *data service objects*. [AF98] p. 434 does likewise and suggests the synonym *conceptual object*. [SC98] p. 8 et seq. differentiates the domain-oriented *business objects* from *GUI* widgets, *elementary objects* (e.g. numbers, strings), *computational objects* (various support objects related to user interface, computing, operating system services, etc.), and *collections* of other objects. Similarly, [OMG97s] distinguishes *business objects, base types,* and *application service objects*. [CP95] partitions the *things* category of Taligent's user interface *People, Places, and Things* into *familiar desktop elements, extensions of desktop elements, appliances, cursor tools,* and *business objects,* the last of which are said to model real-world entities.

491 [FE95] p. 52

3) *The "analysis object" interpretation.* In the *BOF (Business Object Facility)* and *CBO* (*Common Business Objects)* request for proposal issued by *BODTF* in 1996, a distinction is made between *business objects* as analysis and modelling concepts and *application components* as the "manifestation of business objects within the context of the Business Object Facility".[492] The division-line between the two concepts is, however, not strictly observed in this document, and *business object* may even here occasionally signify a run-time object.[493] Similarly, in *Microsoft's* three-phased *Component-Based Design* method, "logical" objects referred to as *business objects* are identified during analysis.[494] These *business objects* are eventually mapped into physical *components,* which will form the basis of an implementation, although this mapping will usually not be one-to-one.

4) *The "middleware object" interpretation.* When building client/server systems, whose most important constituents typically are a *GUI*-based client (or a web client) and a relational database server, it is common practice to introduce an intermediary layer between the *GUI* and the RDBMS. If an object-oriented language is used, this layer may be organised

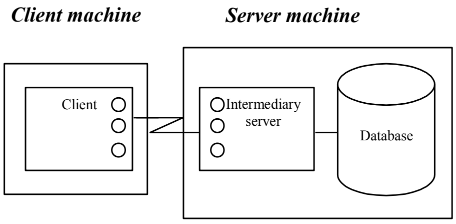

Figure 9. Typical three-tiered client/server architecture

as objects representing domain concepts, which often can be made to correspond neatly to the rows of the tables of the relational database. Such objects are commonly referred to as *business objects* and may be part of two-tier as well as three-tier client/server designs.[495] If a

[492] [OMG96b] p. 2. Cf. also [Sims96a] p. 1, footnote 2. [OMG98c] makes a similar distinction between real-world *things of interest (TOIs)* and the *business software elements (BSEs)* that represent these in a software system.

[493] The *analysis object* usage has been promoted by the employment of object-oriented techniques to model and reshape organisations taken advantage of by some practitioners of *business process reengineering (BPR).* Cf. below p. 131. In [GHY97] p. 290 et seqq., *business objects* are understood as constituents of a special kind of analysis model, the *Business Object Model (BOM),* which may be executable, in case certain tools are utilised. Even if it is, it will not be an implementation, but an "executable specification" that needs to go through a number of complex transformations in order to become an *Implementation Object Model (IOM).*

[494] [Micr97e]. Cf. also [Geor95a] and [MT96]. We will come back to this method below on p. 210.

[495] It should be noted that there is both a *logical* architecture, which deals with how software is split into layers, and a *physical* one, which concerns the distribution of the software layers over physical machines. Some authors, such as [SRHL98], make a distinction between logical *layers* and physical *tiers;* this usage is, however, not widely respected and will not be abode by here either. The chief rationale for the (logical) three-tier architecture is the performance boost and increased scalability resulting from the reduction in network load that will be experienced, when all *SQL* statements being part of a transaction as well as their return sets no longer need to be transmitted across the network, but only the input and output "net data" of high-level transactions have to travel this expensive way. Additionally, whereas in a two-tier architecture each client will be connected to the database by at least one resource-consuming database connection, such connections may be pooled and shared in the middle tier of a three-tier design, thereby increasing scalability greatly. In particular, three-tier design seems to be a *sine qua non* for adequate performance over low-speed connections. Another advantage often claimed (see e.g. [Kara98a] p. 72 and [Nich98] p. 24) is the possibility of making changes to business logic without having to update all client machines. In our experience, updates in multi-tier systems, however, tend to involve all layers, and thus each extra tier exacerbates, rather than alleviates the update process. [HN97], also noticing this obnoxious *ripple effect,* criticise *business objects* for unsuccessfully trying "to give an atomic appearance to what is inherently distributed logic" and claim that *business objects* are little more than data structures – artificially packaged as objects – passed between the *GUI* and the database, which both, rather than the *business objects,* house the significant parts of the *business logic* (input validation, access controls, integrity constraint checking, etc.). As the standardisation of the *business objects* of an organisation is extremely arduous and only seldom attempted, these data-oriented, functionality-deprived *business objects* will not be reused to any significant extent either. Similarly, [Fowl96] is sceptical about standardised business objects. Cf. also [WP93], [PW94], [Wood95], [Clea96], and [JY96]. From a more general coign of vantage based on the later Wittgenstein's theory of language and his rejection of the correspondence theory of truth, [HKL95] p. 150, question the feasibility of a "general 'business' language for defining the conceptual enterprise schema", insofar as "different language games (uses of language) are tied to different forms of life". [Micr98d] p. 11 enumerates various "strengths" peculiar to three-tiered architectures that use *Microsoft Transaction Server.* For a general discussion of the rôle of business objects in 3-tier client/server architecture, see also [Shel95a], [Shel95d], [HN97], [Lhot97], [Lhot98], [RZ98], and [Salz99].

three-tier architecture is adopted, there are frequently two distinct layers of *business objects:* The one, which may be called the proxy layer, is situated at the far end of the client part, whereas the other is accommodated in the "intermediary server".[496] To the client programmer, the business object layer actually appears as a virtual *object-oriented database system (ODBMS)* and, thus, the *middleware objects* involved could as lief be called *pseudo-ODBMS objects.*[497] In architectures of this kind, the business objects are usually not independent entities, but ordinary programme language objects, being integral parts of an application programme. In contrast, the *Microsoft Transaction Server (MTS),* the linchpin of *Microsoft's* enterprise architecture and now an integral part of its *COM+* infrastructure, supports the construction of middle layers, which consist of independent *ActiveX* components, and *Sun's Enterprise JavaBeans* does the same for *JavaBeans* components.[498]

5) *The "framework-based object" interpretation.* Sometimes, *business objects* are understood as high-level distributed objects built by using an *object-oriented framework,* which is based on or wraps infrastructures like *CORBA* and *CORBAservices*. Such a framework is supposed to simplify distributed object programming and/or raise it to a higher, more abstract level. Robert Prins advocates such an approach in his book on business objects[499] and most of the submissions in reply to the *BODTF Business Object Facility RFP* took a framework-oriented approach, at least partly. *IBM's SanFrancisco* project was an attempt to provide a comprehensive *Java*-based business object framework for business applications.[500]

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[496] These two categories of *business objects* correspond to the *model* and *entity* objects of [Sims94] and the *UI-centric* and *data-centric* objects of [Lhot98] p. 57 et seqq. There is no generally accepted term for the intermediary part of a three-tiered client/server system. Names that one may more or less frequently come across include *domain server, infoserver, information server, application server, middle layer/tier,* and *business server/layer/tier.* If the *business objects* on the intermediary server are accessed through *CORBA* or *DCOM,* the "proxy layer" may, at least in principle, consist of *CORBA/DCOM* proxies. Cf. also [Cumm99], who attempts to set down various requirements for *CORBA*-based middle-tier business objects.

[497] In [Pers96], this idea is described as an architectural pattern. Arguably, the extensive tinkering with middleware object layers often attempted in object-oriented client/server systems boils down to nothing less than the construction of a custom object-oriented database on top of an *RDBMS*.

[498] As a rule, transactional components differ from traditional objects by being *stateless,* maintaining no state data in memory between transactions. Instead, transactional components will read their state from the database at the start of each transaction and save modifications back before the completion of the transaction. Cf. [Box98b] and [Box98a] p. 377 et seqq. Scalability is made the point of statelessness in [Sess98a] p. 249 et seqq., [GLJ97] p. 164 et seqq., [Kirt99] p. 81 et seqq., and [Chap98a], but this view is questioned by [Box98c], [Patt98a], and [Ewal99], who all emphasise that the requirement for statelessness derives from the semantics of transactions rather than from scalability concerns, as often purported. Cf. also [BBES99] p. 199 et seq., [Lhot97] p. 510 et seqq., and [Lhot98] p. 525 et seq. At any rate, statelessness will obviate some programming habits that definitely do not make for scalability, such as invoking a remote object repeatedly or holding on to data base connections, record locks, and server-side threads for extended periods of time. Cf. also [HS00] p. 340 et seqq., where a distinction is made between a *type-based* and an *instance-based* architectural style. For a general discussion of the handling of state in *MTS*-based applications, see [Krou98].

In *Microsoft* documents, the designation *component, MTS component,* or *application component* is generally preferred to *business object* for components intended for execution within *MTS*. There is, however, another, specialised usage of the term *business objects* in *Microsoft* literature as the designation for *COM automation objects* that are part of an *RDS* middle-tier. In many cases, such objects will execute within *MTS,* although they may also exist outside *MTS*. See below p. 210. *Microsoft Transaction Server* and *Microsoft's DNA (Distributed interNet Applications Architecture)* are surveyed below on p. 535 et seqq. and in [Pers99a], [BBCE+00], [Moni99], [Kirt99], [Sess98a], [HS98b], and [GLJ97]. *Sun's Java 2 Enterprise Edition/Enterprise JavaBeans* initiatives aim at the construction of a competing *Java*-based enterprise architecture, and *OMG's CORBA* may be regarded as yet another enterprise architecture, more or less fully implemented by *CORBA* products, such as, for example, *IBM's ComponentBroker*. The *Enterprise JavaBeans* specification [DYK01] differentiates two types of components, *session* and *entity beans*. *Session beans* are much like *MTS components* and may be either stateless or stateful. An *entity bean* represents specific data – typically a record – in a database, and, unlike a *Session bean,* it must have a unique key, use transactions, and support multiple simultaneous users. Support for *session beans* is mandatory for *Enterprise JavaBeans* compliant products, whereas *entity beans* were optional in the first version of *EJB,* but became mandatory in *EJB 2.0* together with the session-like, but asynchronous *message-driven beans*. [Sess98b], [Sess99a-e], [RÖ99a-b], (cf. also [Sess00a] and [Roma00]), [Chap98d], [Micr98l], [Viza98], and [Lint99] pits *MTS* (or *COM* or *DNA)* against *Enterprise JavaBeans* (and *CORBA).* See also [Thom97], [Byou98], [Morg98], [Orch98], [Berg98], [FFCM99], [AW99], [Roma99b], [VR99], and [FMMS00]. Cf. also p. 95 et seq. above.

[499] [Prin96] p. 68 et seqq. and 274 et seqq. and passim.

[500] See http://www-3.ibm.com/software/ad/sanfrancisco. [DHA96], [AD97], [Bohr97], [BJNR98], [Bohr98], [IBM99], [John99a], [MCD99], [JBD99], [BS99], and [CCG00] treat of *IBM's* huge *SanFrancisco* framework, which was finally withdrawn in 2001, being replaced by the *WebSphere™ Business Components*. A large number of software development companies were involved in the *SanFrancisco* project, which aimed at the construction of a *JavaBeans*-based component framework for "business applications". At its highest level, this

6) *The "executable object" interpretation.* The understanding of a *business object* as an object-oriented, independently executable *shape* for *deliverables,* in contrast to the *shape* of the traditional monolith *application,* was pioneered by Oliver Sims in his seminal book *Business Objects. Delivering Cooperative Objects for Client-Server,* although he there mostly prefers the more specific acronym *CBO (Cooperative Business Object).*[501] Why such a generally applicable *shape* is given the attribute of *business* is unclear – save for such historical contingencies as Sims' and the *Newi* group's primarily having had business-oriented applications in mind and Sims' book's having appeared during the heyday of the *Business Process Reengineering* movement. Apparently, Sims and his co-workers at *SSA Object Technology* later felt that there was a terminological problem, since they started using other terms as well, such as *executable object (XO)*[502]*, distributable object*[503]*,* or *object writ large*[504].

7) *The "ultimate component" interpretation.* There is a strong evolutionary link between the meaning assigned to *business object* by Sims and the *ultimate component* interpretation popularised by Orfali, Harkey, and Edwards.[505] These authors distinguish three levels of components: *Interoperable components, supersmart components,* and *business objects*. By and large, the *interoperable component*[506] variety equals plain distributed objects that interoperate on an object bus across language, operating system, network, and machine boundaries. Programmers working with this kind of components bring about interoperability explicitly by shaping the client- and the server-side programme code so as to make the components interoperate. *Supersmart components* (or *supercomponents)* take advantage of a rich assortment of services offered by an infrastructure – such as *CORBAservices, COM,* or *.NET* – in order to make themselves more autonomous, loosely-coupled, and reusable.[507] It seems that at least some *ActiveX, .NET, JavaBeans,* and *OpenDoc* components may come close to this level – in particular those meant to be sold and marketed as shrink-wrapped products. This will be the state of the art today, not too far from Brad Cox' *Software-IC* vision.[508] To take components a step further, a more co-operative species of them, *business objects,* will have to be devised. Even in case these objects have no previous knowledge of each other, they should be able to collaborate. To achieve this, standardised rules for interaction as well as a rich infrastructure providing support for *ad hoc* interactions will be needed. Possibly, such an infrastructure may have the form of an *application framework*. *Business objects* of this ultimate race typically have real-world

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multi-layered framework was intended to include support for such business functionality as general ledger, order and warehouse management, accounts receivable, and accounts payable. Lower layers would support *common business objects* (i.e. objects representing concepts common to many branches of business, e.g. payment, discount, address, currency, etc.) and technical infrastructure. Particulars about the technical design may be found in [IBM97b] and [IBM98a]. [IBM98b] states that the third release of *SanFrancisco,* announced in September 1998, was to contain over 800 components and approximately 750,000 lines of code. In [Sess98c], Roger Sessions pointed out that, since the *SanFrancisco* frameworks are designed to use stateful objects, they would not mesh well with transaction processing software, the watchword of which is *statelessness*. According to Sessions, this architectural flaw threatened to confine *SanFrancisco*-based applications to at best hundreds of users, as the use of stateless objects will be necessary for higher levels of scalability. Cf. also [IBM98c], where plans for the migration of *SanFrancisco* to the programming model of *Enterprise JavaBeans* were described. Apparently, the addition of *entity beans* to *Enterprise JavaBeans* was motivated by the needs of the *SanFrancisco* framework.

501 [Sims94]. Sims' ideas will be treated of at length on p. 142 et seqq.

502 [SSA97a-c] and [SSA98] passim.

503 [ES98] p. 7 et passim. [HS98a] and [HS00] prefer the variant *distributed object*.

504 [Sims96c]

505 [OHE96b] p. 38.

506 This term seems to be an adaptation of the *interoperable objects* of [Betz94] and [Vald95]. Cf. [OHE96b] p. 35.

507 [OHE96b] p. 36 et seq. gives an impressive list of the bells and whistles of such components. Features that may be supported include security, licensing, versioning, life cycle management, support for open tool palettes, event notifications, configuration and property management, scripting, metadata and introspection, transaction control and locking, persistence, relationships, ease of use, self-testing, semantic messaging, and self-installation. Currently, there is a trend to abandon such heavy-laden components. Instead of including complex and similar functionality into every component, the same services may in many cases be provided through a container or execution environment, such as *Microsoft Transaction Server,* which by *intercepting* calls to the component may assume responsibility for some invocations altogether and add infrastructure-related functionality (e.g. transaction management) to others before they are forwarded to the component proper.

508 See [CH86] and [Cox86]. See also p. 28 et seqq. above for an account of the history of the *software component* idea.

counterparts, which in many cases will be business-oriented, and they may be grouped into suites. *Agents* may be considered as a special breed of such business objects.

Clearly, the above interpretations are interrelated, and the last one seems to be intended to embrace all the others.[509]

1.1.1 RELATED TERMS

In addition to *business object,* there are quite a few related terms afloat. We will list some of these below together with a short note of explanation:

- *Distributed object* is a term widely used to signify a *CORBA, DCOM,* or similar "object" made accessible across a network through an *Object Request Broker (ORB)* mechanism.

- *Distributable component* is a term used by Eeles and Sims for a "module" construct used as a "container" of various lower-level constituents (classes, frameworks, etc.) that together form an individually executable business object.[510] Later, Herzum and Sims instead started to use the term *distributed component* in the same sense.[511] It is of note that *distributable/distributed component* is used only for the "modules" of the analysis, design, and construction phases, not for the resulting run-time executable.

- *Distributable object* is the run-time instantiation of a *distributable component,* according to the terminology suggested by Eeles and Sims.[512] In lieu of this term, Herzum and Sims use *distributed object* or *distributed component instance.*[513]

- *Executable object, distributable object, distributed object,* and *object writ large* are, as mentioned above, sometimes used synonymously with *business object* in the executable sense.[514] In his book, Prins uses both the term *business object* and *business domain object* in this sense.[515]

- *Application component* is a term that was introduced by the *BOMSIG/BODTF* committee as the designation of the run-time manifestation of a *business object* (in the *analysis object* sense). This usage of *application component* is ambiguous: It may be interpreted as denoting either a component acting as an independent application or a component *being part* of an application. *Distributable object* is used in the former sense by Eeles and Sims[516], *distributed object* by Herzum and Sims[517]. Furthermore, *Microsoft* uses the term *application component* for *COM+* components intended for use in the *Microsoft Transaction Server (MTS).*[518]

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[509] [ES98] p. 5 et seqq. meritoriously tries to clarify the different meanings of the term *business object* contextually and to reduce the overloading it suffers from as well. See below p. 148.

[510] [ES98] p. 7 et seqq. and passim.

[511] In [HS98a] and [HS00].

[512] [ES98] loc. cit. Similarly, in *Microsoft* documents, the instantiation of an *MTS component* is called an *MTS object*.

[513] In [HS98a] and [HS00], respectively.

[514] The term *executable object* was used already in [Kent78] p. 176 et seq., although in a very different sense and context. Kent's *executable objects* were primarily intended for the representation of constraints and were parts of a proposal for a novel way to model and process information.

[515] [Prin96]

[516] [ES98] p. 7

[517] See [HS98a] and [HS00].

[518] E.g. in [Micr96c] and [Kram96].

- *Thing of Interest (TOI)* or *Real World Thing of Interest for the Business* is used as a synonym of business object in the *analysis object* sense in a *Reference Model Extension Green Paper* published by a subcommittee of the *OMG Architecture Board.*[519]

- *Business Software Element (BSE)* is a term used in the same paper to signify the representation in software of a *TOI*. Thus, *BSE* is synonymous with *application component*.

- *Application object* is a concept used by *OMG* to signify an object that is unique to a particular application and, thus, lacks a standard *CORBA* interface. Such objects are opposed to those with an interface defined by some *OMG* specification, such as *domain objects,* which implement a domain-oriented interface according to a definition established by one of the domain task forces of the *OMG,* and *common business objects,* which are objects implementing *OMG*-specified interfaces that are not domain-oriented or span more than one domain.[520]

- *Enterprise object* is another term sometimes used synonymously with *business object,* in particular in the "middleware object" sense in the context of client/server database access from object-oriented applications.[521]

- *Business component* is occasionally used to signify e.g. an *ActiveX, .NET,* or *JavaBeans* component implementing a business concept.[522] This comes very close to the *"business domain object"* interpretation of *business object*. Eeles and Sims use *business component* to signify an abstract "package" concept, which subsumes all the distributed parts *(distributable components* or *distributable objects)* that implement a certain business concept or entity.[523] In a client/server system, there will typically be at least a *user interface* (client) and an *enterprise* (server) *distributable component* (or *object)* that together form such a *business component.* Additionally, some authors use *business component* more or less as a synonym for *business object;* indeed, this usage seems to have become something of a trend lately.

- *Business object component* is sometimes used synonymously with *business component* or *business object.*[524] For example, this term was adopted in the *Business Object Component Architecture (BOCA)* of the *CBOF (Combined Business Object Facility) BODTF* submission.[525]

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519 [OMG98c] p. 19 et seqq. Notably, this paper was frequently referred to in the lengthy debate in the *BOMSIG* mailing list during the summer of 1999 on the relation between the *ISO RM-ODP (Reference Model of Open Distributed Processing)* standard and *business objects*. Cf. also p. 134 below for a discussion of Eriksson's and Penker's somewhat similar concept of *resources*.

520 Cf. also [Shel94a] and [Shel95n], where three categories of objects are discerned: *Business objects,* which "represent a person, place, thing or concept in the business domain", *technology objects,* which "represent a programming or technology concept" and should be "off-the-shelf technical assets", and *application objects,* which are "custom-built to solve business problems". [JCJÖ92] p. 290 differentiates high-level *application objects* from low-level *component objects*. Whereas *component objects* implement technology-oriented concepts such as linked lists or windows, which mostly are hidden in analysis and design diagrams, *application objects* here represent concepts that are present in such diagrams and also shared between multiple applications – i.e. *domain objects* and *common business objects* (rather than *application objects)* in *OMG's* parlance. [Prin96] p. 192 et seqq. lets *application object* signify a short-lived object or "application", which represents a "fixed pattern of business events".

521 See and [Grif98] p. 23 and [GC97] p. 164 et seqq. In particular, this term was used for business objects that took advantage of the *Enterprise Objects Framework* of *NeXT's OpenStep*.

522 See e.g. [Bast97] or [EP00] p. 381 et seqq. [RSEM+97] p. 22 et seqq. differentiates objects at three architectural levels: *Managed objects* are the most fine-grained entities and are mainly intended for data access. *Business objects* are somewhat coarser objects providing support for "business logic". They are suitable for "domain experts" and are implemented as *Enterprise JavaBeans* components. The highest level is made up by visible *business components* intended for "business experts". These components, which include a complete user interface, can be assembled by end-users without the use of *RAD* tools. Each *business component* comprises a *Java bean,* a "model object" (i.e. a business object), and zero or more "view objects". [Schm99a] also understands a *business component* as a rather coarse-granular building block, which may be implemented as, for instance, a *Java* bean, integrating many fine-grained *business objects,* and discerns two categories of fundamentally different *business components, viz. entity* and *process components*. [TK00] p. 150 define a *business object* as "what would be called a "class" in an object-oriented system" and a *business component* as a "set of classes (including business classes and system classes) that support a defined business area". For instance, a *business component* "Invoicing" may contain the *business objects* "Customer" and "Invoice controller".

523 [ES98] p. 11 et seqq.

524 In [Suth95a], [Suth97a-b], and [Suth99], the terms *business object, business component,* and *business object component* are apparently used indiscriminately.

- *Business application component* is a term used by Tom Digre in an influential paper[526] where he argues for "component-based solution provisioning" along similar lines as Brad Cox in his *Software-IC/silver bullet* papers.[527] These *business application components* are envisioned to be built by *IT provisioners* on the foundation of a rich multi-layered infrastructure[528] and to be assembled into applications by empowered *business users,* who employ various tools such as "business rule tools, work flow tools, presentation tools, software assembly tools, data access tools, and integrated CASE tools".[529]

There are also a number of more general terms, including *object, component, ensemble, agent,* and *actor,* from which it might be illuminating to differentiate the *business object* notion. Before this can be done, we will, however, need a working definition of the term *business object.*

1.1.2 BUSINESS OBJECTS – AN ATTEMPT AT AN ECLECTICAL WESENSBESTIMMUNG

Will it be possible to arrive at a consensus about the meaning of the term *business object?* This is doubtful, simply because the disparate meanings have their roots in disparate contexts and outlooks. Just as *object* means different things to an analyst, a *C++* programmer, and a compiler specialist, *business object* takes on different meanings when used in business engineering, domain analysis, client/server architectural design, and programming. Nevertheless, if we try to grasp the essence of the concept, we may be able to identify some common residual, as has been possible for the term *object,* insofar as most people will accede to the view that objects are distinguished by the support for a number of fundamental, reasonably well-defined object-oriented concepts such as encapsulation (of data and behaviour), polymorphism, and inheritance.[530]

Just for the sake of finding the essence of *business objects,* let us now cross the confines of descriptive philological analysis and instead enter the slippery slopes of prescription for a while. I would then argue that the true essence of *business objects* lies in their direct correspondence to real world entities as well as in their generality – *business objects* typically cross application boundaries and, thus, are, potentially at least, *reusable assets.* I do not think it is a good idea to constrain the concept to the *business* sphere, nor to regard it as a pure analysis construct – *business objects* may exist in an analysis model, in a programme design, and in the implementation of this design. Indeed, the ensuing transparency between reality, the different models produced by analysts and programme architects, and the resulting software implementations seems to constitute a major allurement of the approach. Furthermore, I do not believe that *business objects* should be confined to the realms of middleware. On the contrary, an implementation of a *business object* may or may not include one or many visual client-side representations, and it may or may not include a server-side database representation – if this is the case depends on the implementation strategy opted for. To make the definition of *business objects* dependent on a framework implementation appears to me a highly pregnable approach, since it ought to be possible to choose implementation strategy as well as implementation language freely.

Although I would prefer the term *executable object* for the species of *business objects* proposed by Oliver Sims (and others), I believe it might be quite hard to reform the established usage in this respect. In any case, Sims' kind of medium- to large-grained, independently executable *business objects,* subsisting on top of a rich infra-

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525 [DENS+98a-b] and [EDIG+98a]. The adoption of this somewhat clumsy term in the *BOCA* proposal, which originally was named *BOA (Business Object Architecture),* was primarily motivated by the name clash with the *Basic Object Adapter (BOA)* technology of *CORBA.*

526 [Digr95]

527 See [Cox90a-b] and [Cox92].

528 The suggested infrastructure, which is moulded on the *OMG* architecture, contains the following layers: *Platforms, ORB, Object Services, Facilities, Vertical Domains, Enterprise Integration Model (EIM),* and *Business User Empowerment.* The last two items are not part of the *OMG* model, but are outlined in the paper. It is suggested that the *EIM* concepts should be introduced into the *OMG* compages through the *BOMSIG* initiative. This has subsequently been attempted, at least partly, in the *CBOF* proposal, among the authors and originators of which Digre counts.

529 [Digr95] p. 157

530 Of course, some schools of thought would take exception to this simplistic description. A number of different *object models* are surveyed in [Mano97].

structure and capable of many wondrous tricks, such as transparent distribution and semantic messaging[531], will to many of us offer the true attraction of this field.

In order to avoid ambiguity, we will introduce a distinction between *business objects* in the *core* sense and in the *extended* sense. The essence of the former sense lies in the correspondence between real-world entities and their models, the *business objects*. The latter sense expands this simple idea by the additional requirements for independent object executability, loose coupling, and semantic messaging that issue from the grand vision of how computers should present themselves to users and interact with them put forward by Sims in his writings – a vision that will be subject to closer scrutiny below.

In addition to stand-alone execution, *extended business objects* should in our opinion support *composability* by adherence to the protocols of a component or compound document technology, such as *COM/ActiveX, .NET,* or *JavaBeans*. Hereinafter, we will refer to *extended business objects* that support both the independent and the component mode of operation as *Janus-faced objects*. Such *Janus-faced objects* must provide for the loosely coupled style of interaction typical of the former mode (through, for example, semantic messaging) as well as for the more tightly integrated style used in compound document and component interoperation (through, for example, the implementation of certain interfaces). Whereas independent execution, loose coupling, and ad hoc interoperability are essential characteristics of *extended business objects,* the capability to operate as a component is to be regarded as a more or less accidental commodity, albeit one that will admittedly augment the usefulness of the *business object* significantly. Hence, in our terminology entities supporting component interaction only, but incapable of stand-alone execution and ad hoc interoperability, will not qualify as *business objects* – they should rather be labelled *components* or *business components*.

Paradoxically, the attribute *business* is rendered inane by the above analysis – neither in the *core,* nor in the *extended* sense does the *business object* concept have any special links to the *business* area, but is much more general in scope. Still, the term *business object* has gained such popularity that any attempt to tamper with it would most probably be doomed beforehand.[532]

As indicated by the very name, *business objects* are *objects,* but of a special kind – viz. objects representing real-world concepts. Thus, they should support the characteristics of a *bona fide* object – whatever these may be. However, this does not imply that *business objects* are necessarily language objects, although at times this will be perfectly possible. On the contrary, the *extended business objects* are more large-grained than language objects, much more loosely coupled than these, and capable of independent execution. Below, our concern will be primarily with business objects in the extended sense – these are in our contention the true protagonists on the *business object* stage.

1.1.3 BUSINESS OBJECTS AND SOME OTHER CONCEPTS

It may also be elucidating to contemplate how *business objects* relate to some other units of encapsulation such as *components, ensembles, agents, actors, models,* and *objects*.

Business objects in the *extended* sense may be classified as a special breed of *components,* or even as the most consummate kind of components, as exemplified by the *"ultimate component"* interpretation mentioned above. However, what a *component* is remains a major bone of contention.[533] The understanding of the word has changed fundamentally during its history, and it is used in quite different ways within different traditions. If, somewhat simplistically, a *component* is understood as an entity compliant with a commercial component technology such as *COM/ActiveX, .NET, JavaBeans,* or *OpenDoc,* a *business object* may or may not be a *component,* depending on whether it adheres to the set of rules stipulated by such a technology or not – indeed, we just argued that it should do so. How to build an infrastructure for *extended business objects* on the foundation of a

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[531] This concept will be explained below on p. 152.

[532] So also [Lewa98] p. 21, who nevertheless suggests the term "domain object". Since some business objects are known not to be domain-oriented, this suggestion does not seem to be very fortunate.

[533] See above p. 24 and [Szyp98a] p. 164 et seqq. At the root of the definition problems lies the fact that *software components* provide a high-level, conceptual *vision* of how to build software, not a detailed technical recipe hereof. How to bring this vision into life is not self-evident and, thus, an issue subject to dispute.

commercial component technology is an interesting research problem, currently addressed by us in the *Panopeus* project.[534]

In Oliver Sims' vision of the brave new world of *business objects,* monolithic applications are no more, but have been replaced by independent, loosely coupled *business objects.* In contrast, present-day *components* are generally conceived of as units to be composed by programmers into monolithic applications. Of course, *components* may – in particular if they represent fine-grained or technology-oriented concepts such as *GUI* widgets, as is usually the case presently – be assembled into *business objects* as well as applications. Some *business objects,* which we called *Janus-faced* above, may be capable of disguising themselves as *components,* e.g. in order to support the tight visual integration typical of compound documents.

Ensemble is a term used by a few authors to designate "named collections of tightly coupled components with restricted external visibility".[535] During analysis and design a system may be partitioned into *ensembles* with a considerably less intimidating surface area than an unensembled "sea" of objects or procedures. *Ensembles* may be packaged as, for example, *ActiveX* or *JavaBeans* components or as business objects, although there are also various other possibilities.

Agents are close relatives of *extended business objects.*[536] Just as is the case with *components,* there is no universally agreed upon definition of the term *agent,* and widely different classes of agents exist, including both *mobile* and *static* agents, *adaptive* and *non-adaptive* ones, as well as *active/proactive* and purely *reactive* variants.[537] *Business objects* as presently known are static, non-adaptive, and purely reactive and do not usually attempt to implement the element of *artificial intelligence* mostly considered an important part of the agent picture, although it would be easy to conceive of various new kinds of mobile, adaptive, proactive, or intelligent *business objects.*[538] Additionally, *business objects* differ from most types of *agents* by being *objects* in the object-oriented sense and by impersonating real-world concepts.[539] *Business objects* communicate through messaging in a fashion similar to that commonly used by agents, although the messaging syntax will be very different. Indeed, it may be argued that

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[534] [SSA97a-c] is an attempt to define how this might be done on a *CORBA* foundation. We will come back to this topic on p. 222 et seqq. below.

[535] So [Love93] p. 110 and [Suth95b] p. 275. A somewhat different understanding of the term can be found in [CP95] p. 64, where a *Taligent* application is said to consist of an *ensemble* of pieces of framework code. The word *ensemble* is also used in an entirely different sense in [Gele91] as explained on p. 276 below.

[536] [Bake97a] provides an interesting comparison of Sims' *CBOs* and *agents,* which is discussed in footnote 731 on p. 153 infra. [Gris00] regards agents as "an evolution or combination of distributed objects, active objects, business objects and scriptable components". [DOAW99] discuss the relations between *agents, objects,* and *components.* Cf. also [Carl98], [Rost98], and [Rost99]. [Kay84] and [Kay90] state that the *agent* idea was pioneered already in the mid-50s by John McCarthy in his *advice taker* programme (described in [McCa58]) and that Oliver G. Selfridge actually used the term *agent* already at this early time. In [Self58], Selfridge, however, uses the word *demon* for what appears to be an *agent* in today's vernacular. In fact, J. C. R. Licklider (in [Lick68]) contrived the sumptuous acronym *OLIVER (On-Line Interactive Vicarious Expediter and Responder)* in honour of Oliver Selfridge to signify "a complex of computer programs and data that … acts on behalf of its principal, taking care of many minor matters that do not require his personal attention and buffering him from the demanding world". [Kay90] p. 203 contrasts *direct manipulation* of objects with *indirect management* through agents and sees both as manifestations of important primordial principles, and [SP97] contains excerpts of an interesting debate between Ben Shneiderman and Pattie Maes on the virtues and vices of agentry and direct manipulation, respectively.

[537] [FG97] surveys different definitions of agents and also proposes a new one: "An **autonomous agent** is a system situated within and a part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future." This paper also discusses how to classify agents by attributes such as: *reactive* (syn. *sensing and acting,* responds to changes in the environment), *autonomous* (controls its own actions), *goal-oriented* (syn. *pro-active or purposeful,* does not only react to changes in the environment), *temporally continuous, communicative* (syn. *socially able,* communicates with other agents and possibly with humans), *learning* (syn. *adaptive,* changes its behaviour based on experience), *mobile, flexible* (not scripted), and *character* (appears as having personality and emotions). An attempt at a taxonomy of agents is also given, according to which the class of *software agents* is a subspecies of *computational agents,* these in turn being a subspecies of the much more general class of *autonomous agents,* which also comprehends *biological agents* (i.e. living organisms) and *robotic agents.* Cf. also [WJ94].

[538] [Vird] contributes an intriguing proposal for a *MuBot (Mobile Unstructured Business ObjecT)* infrastructure, which aims at the combination of mobile agent and business object technology. Advocating the need for real-time analysis and decision support tools for managers, [MKK00] suggests "a new paradigm for building and using Business Information Systems", in which a new breed of agents called *Active Business Objects (ABOs)* are used to encapsulate business objects.

[539] Some proposals for object-oriented agents exist. For example, [KJ98] p. 71 et seqq. delivers an extended plea for object-oriented agents, although the proposed agents are used to model "activities" such as "financial info search" rather than the real-world entities represented by business objects. Furthermore, these object-oriented agents will not be independently executable, but are implemented as language objects subsisting within the confines of an application written in an object-oriented language. Cf. also [Rasm99b].

business objects are agents of a special kind, or, conversely, that agents constitute a subdivision of *business objects.*[540]

Actors are technically somewhat similar to both agents and extended business objects, but have been used primarily in the context of research within areas such as formal methods, distributed and concurrent programming, and parallel and fault-tolerant computing.[541] Just like business objects, *actors* are reactive objects, which interact through message passing and execute methods on message receipt. They may also model real-world concepts such as bank accounts and customers, although they seem to be more frequently used to implement fine-grained technology- and computing-oriented concepts. In contrast to business objects, *actors* are *active,* insofar as they encapsulate their own thread of execution.[542] In many cases, this will make the actor approach too inefficient, at least unless exotic parallel hardware is resorted to. *Actors* also differ from business objects by the lack of support for stand-alone execution, inheritance, and synchronous messaging.

Another approach, in which parallelism is taken seriously, is *model-oriented programming,* a refinement of object-oriented programming worked on by a group headed by Dr. Göran Fries at the *Department of Computer Science* of Lund University.[543] In many ways, this approach, which harks back to the simulation and modelling roots of object-orientation, comes remarkably close to Oliver Sims' *business objects* vision, in particular as regards its basic outlook. Important instances of sentiments shared between both approaches will be the emphasis on the modelling of real-world concepts and the preference of message sending to method calls. Of course, there are also important differences. For one thing, both active and passive objects are supported in the model-oriented paradigm. Active objects, i.e. objects encapsulating their own thread of execution, communicate via asynchronous messages[544], whereas passive objects are accessed through ordinary method calls; synchronous messaging may also be supported.[545] In contrast to actors, the active objects of model-orientation support implementation inheritance by taking advantage of some special features of the *SIMULA* programming language (viz. the *inner* keyword and *concatenation).* There are five basic types of objects: *structures* (or *openobjects), monitors, messages, processes,* and *models,* of which the first three are of the passive kind, the last two of the active one. *Structures* are equivalent to ordinary object-oriented objects, whereas *monitor* objects add support for concurrency by serialising method calls. *Messages* are specialised objects, used exclusively for messaging between active objects. *Processes* and *models* are both active objects; the latter differ from the former by being capable of encapsulating other *processes* or *models.* The fact that *model-oriented programming* includes support for the nesting of models and processes inside active *model* objects sets it apart from almost all other parallel programming approaches. Notably, the *business objects* of *Newi* lack support both for the encapsulation of the thread of execution and for nesting, but attempt to reuse the threads of execution smartly while preserving the impression of independent, concurrent execution typical of active objects.[546] Additionally, *model-oriented programming* differs from business objects by being a programming language-based approach, rather than a user interface-oriented one.[547] Thus, it does not share in some of the loftier aims of the business object vision, such as the dismantling of traditional monolith applications.

There will be two basic metaphors implicitly operative behind the curtains of all these technical notions. The *component* and *ensemble* notions are founded on a *machine metaphor,* i.e. a view of a computer programme as a device built in much the same way as most industrial products from more or less tightly coupled *black box* elements, which, in turn, will be composed of other, smaller *black box* constituents. In contrast, the *business object, agent, model,* and *actor* concepts reflect a *world metaphor,* i.e. a conception of the computer or a computer programme as a small world of things and, perhaps, quasi-organisms. Here, the rôle of the "things" is enacted

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[540] See [Bake97a] and [OHE96b] p. 38. Cf. also id. op. p. 255 et seqq. and p. 401 et seqq.

[541] See [Agha86], [Agha90], and [Frøl96]. The actor approach was first suggested by Carl Hewitt in the early 70s (see e.g. [HB77]).

[542] In some actor systems, there may be one writer and multiple reader threads internally in an actor. See [Agha90] p. 128 and [Frøl96] p. 3 note 1.

[543] See [Eina99], [Eina02], [Frie97], and [Hjel98].

[544] Interestingly, the model-oriented approach also supports the broadcasting of messages.

[545] See [Eina02] p. 68 et seqq.

[546] See p. 154 below.

[547] A model-oriented language called *MOPL (Model-Oriented Programming Language),* based on the *SIMULA* language, is currently under development.

by *business objects* and that of the "organisms" by *agents,* while *actors* and *models* will be related to both species of entities. As the two metaphors are by no means mutually exclusive, a *business object* or an *agent* may well be made up of *components* and these *components* may, in turn, of course be put together from *objects*. It is my thesis that the *world metaphor* is especially well suited for the user interface level, in particular when implemented by directly manipulable *business objects,* while the *machine metaphor* is usually preferable in software development – I will develop this somewhat contentious argument at some length below.[548]

[548] See below p. 228 et seqq.

1.2 THE ROOTS OF BUSINESS OBJECTS

The expression *business objects* began to appear with some frequency during 1994-95 and has since established itself as the identification of a distinct domain of discourse, research, and development. It emerged from a number of different areas, the most important of which will be:

- object-oriented modelling (i.e. analysis), design, and programming
- object-based user interfaces
- “business engineering” and “business process re-engineering”
- client/server and distributed objects technology
- software components

Of course, no distinct boundaries exist between the above areas. On the contrary, they are inextricably entangled, although authors writing on *business objects* often emphasise or start out from one or the other of these aspects. Additionally, *business objects,* at least in some of their strains, have been influenced by other domains of software construction as well, such as, for example, *CASE,* database, and *4GL* technology. Below, an attempt will be made to outline the roots of the *business object* idea. Some early forerunners, the ideas of which anticipate important aspects of the *business object* concept, will also be touched upon.

1.2.1 THE OBJECT ELEMENT – OBJECT-ORIENTED MODELLING AND PROGRAMMING

Not only are *business objects* sprung from the beehives of object-orientation, but they are themselves denizens of these very same skeps.[549] In particular, one of the most cherished ideas of object-orientation, to wit that objects should model real-world entities, thereby minimising the *semantic gap* between model and reality[550], is the bedrock on which the *business object* idea rests.[551] To the surfeited observer of current object-

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[549] This can be inferred also from the fact that works on object-orientation by Cox, Jacobson, Booch, Rumbaugh, Wirfs-Brock, Taylor, Reenskaug, Bapat, Kilov, and others are frequently cited in the literature on *business objects.*

[550] [Inga81] takes the philosophically somewhat more sophisticated position that objects should be compatible not with reality *per se,* but with the models of it in the minds of human observers. For a related view, cf. [Aran89]. [HKL95] p. 57 et seqq. distinguish two data modelling “paradigms”, viz. the *objectivist* approach of modelling reality *per se* and the *subjectivist* one of modelling “a subjective construction of the mind” or “a socially constructed image”, and argue that object-orientation will favour the latter.

[551] In [Part96], Chris Partridge disputes the widespread belief that people naturally tend to see and think about the real world in terms of *objects.* On the contrary, people are inclined to regard things as *entities* (or *substances)* that have *attributes,* and this common sense view was codified already by Aristotle as the “substance paradigm”, Partridge contends (id. op. p. 52). Only recently, the substance paradigm has begun to loosen its grip, mainly through the work of Frege and Peirce and some other philosophers and mathematicians, who have contrived a new “logical paradigm”, where *logical objects* may be grouped into *logical classes* and related to each other through *logical tuples.* In this logical paradigm, the *classes* and *objects* of object-orientation make sense, although the *logical objects* – and the “business objects” used by Partridge for *business modelling* –seem to differ from the objects of object-orientation by the lack of behaviour. In fact, Partridge’s “logical paradigm” will be more related to *logical programming* than to *object-oriented programming* or *business objects,* which appear to owe at least as much to the “substance paradigm”. Cf. also [Part94a-b], [BE94], [HKL95] p. 60 et seqq., and [Brya96]. Taking their cue from Heidegger, [CC99] instead argue that objects can be viewed and treated in two distinct modes, to wit contemplatively as present-at-hand *(vorhanden)* and instrumentally as ready-to-hand *(zuhanden),* and that object-oriented methodologies need to take this distinction into account.

Disparate views exist on where to find the philosophical fountainheads of object-orientation. In contrast to Partridge, [Kay93] associates the idea of objects, which encapsulate state and behaviour, with the monads of Leibniz, whereas [Coll95] p. 71 et seq. relates it to Democritus’ atom theory. In our view, the similarity to these concepts seems, however, rather superficial and recherché. More convincingly, both these authors connect the class/instance notion of object-orientation with Plato’s philosophy of ideas. If class-based object-oriented programming indeed has an air of Platonism about it, the classless strain of object-oriented languages, such as *Self* [US87], appears as distinctly Aristotelian in outlook, insofar as Aristotle made Plato’s ideas, □δ□αι, – which Plato and Aristotle frequently also referred to as forms, μορφα□ – coalesce with matter, ὕλη, just like classes and objects are unified into the *prototype* concept of classless object-oriented programming languages.

Objects and object-orientation may also be derived from psychology or anthropology. [Coll95] p. 77 et seqq. discusses cognitive models of objects and their relation to various theories of psychology, including the Swiss psychologist Piaget’s stages of child development and Bruner’s elevation of these stages into separate mental faculties or “mentalities”. It is concluded that the object/action paradigm is characteristic primarily of the *sensorimotor* or *kinesthetic* stage, which also happens to be the first stage of a child’s development, covering the ages 0-2. During the subsequent *concrete operations* or *visual* (age 2-11) and *formal operations* or *symbolic* (age 11-15) stages, the abilities to think in images and abstract symbols, respectively, are developed. Bruner (see, for example, [Brun66]) associated each of these stages with separate mental faculties, which he called the *enactive, iconic,* and *symbolic mentality.* [Kay90] associates different aspects of the graphical user

oriented software practices this core idea may appear utterly hackneyed, and it could be argued that it really is the core idea also of object-orientation in general.

The notion of a correspondence between reality and computer models will come particularly easy to anyone who works on software-based simulations of real-world phenomena, and, quite naturally, computer simulation was the application domain out of which what is now known as *object-oriented programming* and its notions of *classes, instances,* etc. emerged, originally as innovative features of the simulation language *SIMULA* gestated in Norway during the 60s.[552] During the 70s, these notions were generalised by the *Learning Research Group* of *Xerox PARC (Palo Alto Research Center)* into a paradigm of "object-orientation", a universal approach not only to programming, but to computing at large, and a part of the grand vision epitomised by Alan Kay's *Dynabook* concept and his idea of "personal computing as an amplifier for human reach".[553] The *Smalltalk*

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interface to these mentalities: So the mouse and direct manipulation relate to the *enactive* mentality, icons and windows to the *iconic* mentality, and programming languages like *Smalltalk* to the *symbolic* mentality. Cf. also [SCS96].

For an "anthropological" interpretation of "object culture" as a hermeneutically oriented "contrarian subculture" to a "formalist", mathematically and logically founded paradigm of philosophy, which harks back to Descartes, Leibniz, and Hobbes and reached its apogee with the digital computer, see Dave West's contribution in [FCBC+96] p. 289 et seqq. Cf. also [Nels92] p. 1/11 et seqq. and [WF87] p. 14 et seqq. et passim.

[552] The first object-oriented language, *SIMULA,* was devised by Dahl and Nygaard for simulation purposes from 1961 onwards; see [ND78] and [DN66]. The class idea was inspired by Hoare's record classes/subclasses (see [ND78] p. 258). Cf. also [Duga94], who attempts to expound and explicate the advent of object-orientation against the background of an "ideology of simulation" purportedly popular in science at the time. Simulation was also the application area that originally motivated Stroustrup to develop *C++* (see [Stro96a] p. 700 et seqq.). [Cast97] describes a recent upswing in the interest in simulations of complex systems. [TK89] p. 466 mentions that already in 1957 encapsulated object-like "components" were used for the simulation of the *Minuteman* missile system. These "components", which were developed more or less independently of each other by domain experts, had their own state and behaviour and were capable of mutual information exchange. [Booc94] p. 36 et seq. gives a very succinct survey of the history of the "object model", suggesting hardware architecture (descriptor-based and capability-based architectures) as the cradle of "the concept of an object". He describes a number of parallel developments conducive to the emergence and rise of object-orientation – within areas as diverse as hardware architecture, operating systems, programming languages, programming methodology, databases, artificial intelligence, philosophy, and cognitive science. [Kay93] p. 70 et seqq. gives an exposé of various early developments pointing forwards to object-orientation – some of these are also briefly discussed by [Rent82]. Cf. also [Coll95] p. 19 et seqq., [ZNGM91], [Pres93], and [Myer96].

[553] [Kay93] p. 70. Cf. also [Lear76], [KG77], [Kay77], and [Kay90]. Possibly, the terms "object-oriented" and "personal computing" were invented by Kay, although [Davi98] p. 165 credits Stewart Brand with the coinage of the latter (in a 1972 article in *Esquire);* [JL76] contains the oldest instances I have been able to find of the former. The term *object,* which was absent in the first *SIMULA* versions, originates in *SIMULA 67,* where it was used to designate an instance of a *class* (see [ND78] p. 259). Incidentally, the word *object* also plays a prominent rôle in another important source of inspiration for Kay and the *PARC* researchers, to wit the staged theory of child development put forward by Piaget (see. for example, [Piag54] p. 1 et seqq.). *Personal computing* builds on the idea of *interactivity,* for which the *Whirlwind* project at *MIT* blazed the trail (see [Ross88], [HMTR+89], and [HMGR+89]). Interactive "conversation" between computer and man was the centrepiece of Douglas Ross' ideas about *Gestalt programming,* published as early as 1956 [Ross56]. An important step towards interactivity and personal computing was of course time-sharing [Stra59], by means of which the semblance of a number of small personal computers could be created. Another was the arrival of interactive programming languages such as *JOSS* [Bake78] and *BASIC* in the early 60s. Cf. also [Nels98] for some remarks by Ted Nelson on his own early ideas on portable (and wearable!) computers. [Rhei00] and [Rhei91] p. 68 et seqq. track the intellectual foundations from which personal computing sprang, whereas [Hilt99] and [SA99] chronicle the *Xerox PARC* saga.

J. C. R. Licklider, who at *Bolt Beranek and Newman (BBN)* had led the development of one of the first timesharing systems, provided, as it were, the manifesto for interactivity in his famous paper on *man-computer symbiosis* [Lick60] (expanded upon in later papers on *man-computer communication* [LC62] and *man-computer partnership* [Lick65]), where he suggested a variety of advanced interaction techniques, including graphical desk-surface displays capable of character recognition – and thus acting as combined I/O devices – as well as wall-sized displays, recognition of natural language voice input, automatic speech synthesis, etc. He also argued that computers should be connected with each other and with users through communication networks, and in the famous paper [Lick68], *The Computer as a Communication Device,* he develops this idea into a vision of something not too far from today's *Internet.* Licklider was in 1962 appointed director of the *Information Processing Techniques Office (IPTO),* which was part of the *Advanced Research Projects Agency (ARPA)* of the U.S. *Department of Defense.* From his *Pentagon* position, he was able to support a variety of research efforts conducive to the realisation of the man-computer symbiosis/partnership vision. [Kay98] startlingly comments upon "Licklider's dream of symbiotic computing and a worldwide network" and its influence on the research community thus: "The ARPA future was a magnetic field and all the little iron filings lined up more or less pointing into the same direction, just taking different paths." Men like Ivan Sutherland and Robert Taylor, who followed Licklider as directors of *IPTO,* largely shared his vision, and Robert Taylor was in 1970 hired by *Xerox* to organise the *Palo Alto Research Center (PARC).*

The notion of the augmentation of man's capabilities was another significant driving force for the development of *personal computing.* One important source of inspiration for this idea was Vannevar Bush's seminal article *As We May Think* [Bush45] published in *The Atlantic Monthly* in June 1945, proposing a computer-like device intended to augment man's memory. Bush envisioned this tool, which he called the *Memex,* to be equipped with a keyboard, knobs, levers, and two displays. Inside the *Memex,* the user, primarily anticipated to be a scientist or scholar by Bush, would be able to store all his books, records, and communications on microfilm and to annotate them and

programming language, which was designed by Kay, and the *ALTO* personal computer, originally known as the *Interim Dynabook,* were attempts made at *PARC* to make good some of the most significant parts of this vision.[554] Kay also entertained the idea of an *integrated environment,* disencumbered of any artificial division lines between operating system, programming environment, and applications.[555] The *Smalltalk* systems running on the *ALTO* essentially were such integrated environments, utopian habitats where the habitants were objects and all their capabilities were available simultaneously to the user through overlapping windows – another innovation of Kay's. The *PARC* endeavour broadened the domain of object-oriented programming from the rather narrow realms of simulation to software construction in general, and, most importantly, connected object-orientation to the ideas of personal computing and a graphical object-based user interface.

Object-oriented research after the 70s has largely been concerned with filling in the gaps in the conceptual structure erected by the *PARC* pioneers. How to combine persistence, distribution, or multiple threads of execution with the object-oriented style of programming are some important problems that have received considerable attention and begotten new sub-technologies, such as object-oriented databases and distributed objects.[556] During the 80s, object-orientation slowly began to seep through the walls of the research laboratories and become part of mainstream software construction. As a consequence of this process, the new and as yet immaculate technology increasingly had to adapt to and cope with also the lowly and mundane aspects of computing, such as efficiency, operating system and *GUI* interfacing, portability, and legacy integration. A proliferation of object-oriented languages resulted[557], out of which the hybrid language *C++* was to come out by far the most popular, largely profiting from its backward-compatibility with the

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create arbitrary links between them. [NK91] is a treasure-trove of information on Bush and his aftermath and also contains several papers by Bush himself. Cf. also [SRMD96] and [Toyn88] p. 162.

Bush's article inspired Douglas Engelbart's long-ranging endeavour to realise these ideas through computers at the *Augmented Human Intellect Research Center* of the *Stanford Research Institute* (see, for example, [Enge62], [EE68], and [EEB67]). From this effort sprang, among other things, the first full-screen word processor, (tiled) windowed displays, the mouse, video conferencing, collaborative editing, and the first usable hypertext system. The term "hypertext" was coined in 1965 by Ted Nelson [Nels65], whose *Xanadu* project aimed at making the entire world literature, which Nelson aptly calls the *docuverse,* available on-line as hypertext (see [Nels72], [Nels74], and [Nels92]), a vision that by now is not too far from coming true through the world-wide web. As pointed out in [Nels95], there was, however, a fundamental difference in outlook between Engelbart and Nelson: Engelbart wanted to "empower work groups and make them smarter", Nelson to "free the individual from group obtuseness and impediment". [Conk87] and [Niel95] p. 33 et seqq. offer surveys of hypertext systems and their history. Engelbart's work was an important source of inspiration to Alan Kay and people from Engelbart's laboratory were recruited to *Xerox PARC* in the early 70s ([Kay93] p. 74). Negroponte's *Architecture Machine,* described in [Negr75], was another important attempt to augment man's capabilities by the use of computers, although only within one particular domain, viz. that of architectural design. This effort also differed from Engelbart's and Nelson's by its focus on machine intelligence. This AI emphasis was also in contrast to Frederick Brooks' programme of *Intelligence Amplification (IA),* according to which computers should be used not as intelligence simulators, but as *tools* for tasks such as complex computations and the storage and search of large amounts of data, for which human beings are not well equipped. Men should, Brooks submits, remain in control of the tasks, in which they excel and which typically involve different aspects of "intelligence", such as strategy, planning, pattern matching, evaluation, understanding context, and the like. See [Broo77] and [Rhei91] p. 36 et seqq. Likewise, [Moul93] p. 86 et seqq., discussing Zuboff's ideas (in [Zubo88]) about the use of computers for *automating* and *informating* and the bearing of these ideas on virtual reality, concludes that the current trend is to give up the closed control loops of the automating approach (exemplified by the artificial intelligence project) for an "informating" approach, where machines "informate" men, who, remaining in full control, use the feedback from the computer to make the important decisions about their work themselves.

Following in the footsteps of [Druc68], [Coll95] p. 28 et seqq. regards the need for the augmentation of human capabilities as a natural consequence of a long-standing trend from "production work" to "knowledge work" – a trend that, in turn, emanates from the automation of "production work" through the use of computers and other kinds of machinery. When simple, repetitive tasks are automated, what will remain and become increasingly important are the unstructured, knowledge-intense, and complex tasks, usually involving a considerable amount of decision-making. In order to arrive at well-grounded decisions, the "knowledge worker" will need to be augmented by a plethora of computer-based decision support tools. Whereas "production workers" – such as touch typists – usually work with only one or a few tasks and applications, knowledge workers will, as pointed out in id. op. p. 61, be prone to jump between a plethora of tasks and, consequently, will be much more volatile in their needs of tools. Cf. also [Kidd94] and [Enge82]. [Lévy97] p. 31 et seqq. contends that we are currently witnessing the automation also of information work. The economy of the future will revolve around the truly irreducible, to wit "the production of the social bond, the relational". The result will be a "human economy", "the economy of collective intelligence", where loosely organised people will co-operate and share knowledge for all kinds of purposes through the instrument of the computer and the new hypertextual knowledge space, which Lévy calls *cosmopedia.* Cf. also [Lévy98].

[554] [Kay93] p. 77

[555] [Tesl81] p. 94 et seq.

[556] [WCPP+98] surveys "object-oriented information systems" and proposes a classification of its different subject areas.

[557] [Saun89] surveys no less than 88 object-oriented languages.

omnipresent *C* systems programming language, although lately the *Internet* furore has made the *Java* language loom into the foreground as well, mainly due to the portability and security advantages implied by its byte-code-based execution model. *C++* and some others of these languages were powerful and fast, but in order to be so they had to compromise the ideals of simplicity, flexibility, interactivity, and user (child) programmability prominent in the *Xerox PARC* efforts.

Since the late 80s, object-oriented modelling, analysis, and design have made their way into the standard repertoire of system development, and the idea that software objects should reflect real-world entities has become a commonplace of the object-oriented methodology literature.[558] Incidentally, object-oriented modelling is widely used also for purposes other than system development, such as the modelling of networks or organisations.[559] Lately, the proliferation of methodologies and notations has been somewhat stemmed by the almost universal acceptance of the *Unified Modeling Language (UML),* which has also been widely embraced by the *business objects* community.[560] As *business objects* are the kind of real-world entities that interest analysts, there are naturally strong interconnections between the realm of object modelling and analysis and that of *business objects,* as can also be seen from, for example, the proceedings of the *OOPSLA Business Object Design and Implementation* workshops[561] or the discussions of the *BODTF* meetings and mailing lists[562], although there are also many who approach the field in a more technical manner.[563] We hold that these perspectives need not – and, indeed, should not – be treated as inconsonant or at variance, and we will here attempt to give each of them its due without any browbeating on account of the one or the other. Cruising between Scylla and Charybdis is always difficult, so this policy will probably make us appear overly concerned with technical detail to some and not enough so to others.

For all their object-oriented virtues, *business objects* extend the traditional conception of an object in important respects. Most importantly, they need support for distribution, and they should enjoy a much larger degree of independence than the objects known from object-oriented programming languages. This makes *business objects* encroach upon the realms of distributed objects and components – realms of which they are often also taken to be an outgrowth. We will come back to this encroachment frequently. Anyhow, the *extended business objects* envisioned by Sims may well be understood as a re-establishment of the user-centred "objects everywhere" approach at play at *Xerox PARC* during the 70s, aiming at the amplification of human reach by the direct manipulation of visual objects that simulate, represent, or correspond to real world concepts.

1.2.1.1 Excursion: Some Early Precursors

Outside object-orientation, the idea of a close correspondence between the real world and software implementations is also embodied in, for example, classical *entity-relationship (E-R)* data modelling[564] and in

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[558] A few examples from some popular books on object-oriented analysis and design will suffice: [WWW90] p. 7, [RBPE+91] p. 4, [JCJÖ92] p. 42 et seqq., [Booc94] p. 39 and p. 81 et seqq., and [BRJ99] p. 6 et seqq. [Jone78] introduced the concept of an *object model* as a general modelling tool. [Wier98], a comprehensive survey of object-oriented (as well as structured) specification methods, states that since 1988 at least 19 object-oriented methods have been published in "book form". [WN95] p. 15 claims that 20-50 object-oriented methods had been "published" to date, depending on what is considered a separate method.

[559] [Bapa94] primarily deals with the modelling of communication networks. Modelling of organisations is a major concern of *business engineering* (see below p. 132 et seqq.).

[560] For example, [Hrub98], [Kort98], [SK98], and [KK99] discuss the relation of *business objects* to *UML*. [Fowl97] provides a primer of *UML*.

[561] See [SPCH+97], [PSM98], and [PSM99]. The web pages referenced in footnote 469 contain links to some papers that are not included in the printed proceedings.

[562] See http://ftp.omg.org/docs/bom and http://www.omg.org/archives/bomsig.

[563] Some categories of technology experts that play an important rôle in object-orientation at large have been conspicuously absent from the discussions on *business objects,* including compiler constructors and programming language designers. Although this absence may put off some people of a strong technical bent, it is largely a consequence of the simple fact that programming language concerns are not very germane to the field. Additionally, a plethora of other technical issues, including some very difficult ones concerning topics such as distribution, persistence, data integrity, and security, is of paramount importance here, as we will see below.

[564] [Chen76]. Cf. also [Gess92], who explicitly made E-R modelling the starting-point of his business objects approach. E-R modelling and the other ideas mentioned in the current section belong to the early stage of "barely seeing" a concept in formation, according to the life-cycle terminology suggested by [Kay93] p. 70.

some of the *structured knowledge representation* approaches used in artificial intelligence, such as *semantic nets* or *frames.*[565] Furthermore, in the mid-70s the ANSI/X3/SPARC study group on database management systems proposed an influential three-level schema architecture for data storage.[566] Whereas the *internal schema* of this proposal was intended to model the actual physical storage of data in a database and the *external schemas* to offer user views of this selfsame data, the purpose of the *conceptual schema,* which was interposed between the external and internal schemas, was somehow to support a more direct kind of modelling of the structures of reality. Some ideas of structured programming, such as the notion of the undesirability of inter-module coupling and the desirability of module cohesion, also tend to make for the partitioning of software into modules that have real-world counterparts.[567] In the late 70s, the relationship between information systems and reality was investigated by Kent from a philosophical standpoint.[568]

At about the same time, K. A. Robinson of *Infotech* presented a method for event-based modelling of the dynamics of systems, based upon the ideas of Jackson's *Principles of Program Design*[569], and attempted to treat "the entire data processing system as a gigantic discrete event simulation system".[570] While emphasising the importance of a close correspondence between real-world systems and their software representations, Robinson modelled entities like customer, order, etc. through their behaviour by representing their instances as independent *life history programs.* These were pure fictional constructs, each representing a single real-world object and the unique sequence of events it would experience and react upon during its lifetime. The *life history programs* could be "inverted" into executable code through various manipulations defined by Jackson's method.[571] These steps would eventuate in *variable state subroutines,* shared by all instances of a certain entity, and instance-unique data. The latter would encompass *state variables,* i.e. pseudo-addresses recording the programme positions of each entity, and *state vectors* containing instance data, which could be stored in a *master file* when necessary. Since a system might potentially hold a very large number of *life history programs,* which were expected to be waiting for events during most of their lifetime, these would have to be swapped in and out from secondary storage (the master files) as needed. Robinson conceived of the *life history programs* as communicating through messages and even considered the possibility of communication between distributed programmes. The implementations of these *life history programs* would be somewhat similar to present-day business objects (in the extended sense), although Robinson does not seem to have subjected his ideas to more than, at best, very modest implementation experiments.[572]

1.2.2 OBJECT-BASED USER INTERFACES

Whereas most authors writing on business objects do not take a very strong interest in user interface questions, the *object-based user interface* is the very starting point of Oliver Sims' vision of *cooperative business objects.*[573] In Sims' writings as well as in some other pieces of work, the term *object-based* or *object-oriented user interface* is used to signify a special variety of graphical user interfaces, where the user interacts with the on-screen objects by performing direct-manipulation operations on them.[574] The development of *graphical user*

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565 See [Rich83] p. 201 et seqq. and [Crev93] p. 73 et seqq. and p. 172 et seqq.

566 [ANSI75]. [HKL95] p. 40 et seqq. gives a concise survey of the history of data modelling and conceptual modelling. Cf. also [RB94] p. 11 et seqq. and [Koss95].

567 [SMC74]. These notions are referred to by some authors on business objects, such as [Sims94] p. 138 et seq. and [Prin96] p. 46 et seqq. Cf. also footnote 732 on p. 153 below.

568 [Kent78]

569 [Jack75] p. 280 et seq. and passim

570 [Robi79]. See also [RB94] and [Hung96] p. 2. Notably, [Prin96] is also influenced by Jackson's ideas (see p. 88 et seq.).

571 [Jack75] p. 169 et seqq. (in particular p. 186 et seqq.)

572 In the heated discussion that followed upon Robinson's presentation of his ideas at a programmer specialist group meeting, the affinity between the *life history program* approach and the classes and coroutines of *Simula* was debated at some length. A transcript of this discussion is appended to [Robi79] on p. 279 et seqq.

573 Sims' seminal work [Sims94] starts with a discussion of usability and user interface issues. Cf. also [Sims95a] and [Prin96] p. 258 et seqq.

574 As stressed by [Coll95] p. 4, there is no consensus as to what differentiates an object-oriented user interface from an ordinary one. Some writers use the term almost synonymously with *graphical user interface,* whereas others, including Collins himself, attempt to establish various conditions that a *GUI* must fulfil to be object-oriented. On p. 89, he suggests these three criteria: 1) Users perceive and act on

interface (GUI) technology is closely intertwined with the development of object-orientation as a programming technique, and the graphical user interface bestows a visual dimension on the modelling of reality that is the seminal idea of object-orientation at large and business objects in particular.[575]

Already in the early 60s, Ivan Sutherland's *Sketchpad*[576], the prototype of all subsequent drawing programmes[577], embodied distinctly object-oriented ideas. In *Sketchpad,* any drawing could be made into a "symbol" or "master picture" – i.e. a class –, from which the operator might create new "instances" or "subpictures". These could, in turn, be combined with other drawing elements in order to create new, more complex drawings or symbols. Internally, all drawing and other elements of a certain type were collected in a *ring* with a shared *generic heading,* which in effect served as the class of these elements.[578] Such *generic blocks* were arranged into a *generic structure,* which acted as an inheritance hierarchy, where *super-generics* or *generic-generics* played the rôle of superclasses. The on-screen objects were drawn with a light pen[579], could be controlled – grabbed, moved, resized, constrained[580] (e.g. inside a circle), removed, etc. – by *direct manipulation*[581] techniques through the pen, and were displayed on a screen, which could be divided into two tiled windows. Sutherland also considered the possibility of associating behaviour with the objects of an electronic circuit drawing made in *Sketchpad* in order to simulate the circuit.[582] A 3-D version of *Sketchpad* called *Sketchpad III* was created by Timothy Johnston.[583]

Graphical user interfaces are often characterised by the acronym *WIMP – Windows, Icons, Menus, Pointers.* Although these four basic elements of a *GUI* became available – at least in a rudimentary form – during the 60s[584], it was not until they were combined with the bitmapped display and the ideas of object-orientation at

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objects. 2) Users can classify objects based on their behaviour. 3) Interface objects fit into a consistent conceptual model. According to this definition, the user interfaces of *Xerox Star, Apple Macintosh, IBM's OS/2 Workplace Shell, Hewlett-Packard's NewWave* and *Microsoft Windows 95/98* would qualify as more object-oriented than, for example, those of *Windows 2.x* and *3.x,* where the user acted on icons that represented applications and files rather than on objects. Whereas the term *object* has an obvious interpretation in a *GUI*, the significance of the *class* and *inheritance* concepts in a *GUI* is less limpid, as pointed out by [Coll95] p. 91. The "stationery pad" metaphor of *Apple Lisa* and *Taligent's People, Places, and Things* and the "templates" of *IBM's CUA* may be understood as *class* objects utilised to create or "tear off" new objects or documents. Additionally, *inheritance* hierarchies of interface elements may be discerned: For instance, the *icons* of the *Xerox Star* were classified as either *data icons* or *function icons. Data icons* could be *documents, folders,* or *files,* whereas *function icons* were things like printers, in/out-baskets, etc. In *IBM's CUA (Common User Access),* interface *objects* are classified as *containers, data objects,* or *devices,* whereas *Taligent's CommonPoint* supports a division into *people, places,* and *things*. [Mand94] p. 229 and [Mand97] p. 197 list a number of issues where *application-oriented* and *object-oriented user interfaces* differ. Cf. also [CP95] p. 75 et seqq.

[Coll95] p. 87 and p. 569 attributes the term *object-oriented user interface* to [Tesl83], where Larry Tesler parallels the "object-operation" command style of the graphical user interface with the "object-message" syntax of *Smalltalk*. The term *object-based user interface* is preferred by some authors, but the two terms are usually used indiscriminately.

575 [Coll95] p. 32 surveys the history of the "object-oriented user interface". [PV89], [Pres93], [BGBS95] pp. 35-47, and [Myer96] are other valuable surveys of the history of the *GUI.* Additional information can be found in [Kay93] and [Gold88].

576 [Suth63a-b]

577 The *Xerox PARC* drawing programme *Draw* was, for instance, co-developed by Robert Sproull, a disciple of Sutherland's. See [JRVS+89] p. 23.

578 In [MS95] and [SU95], the use of graphics to represent internal programme structures is referred to as *structural reification.* In the *Self* programming environment, *structural reification* is used to visualise programming language objects as on-screen *morphs*. Morphs may be attached to other morphs as *submorphs,* composed into *compound morphs,* or changed directly by users through *live editing* without the need to enter a special edit mode.

579 In [Ross88] p. 54, Douglas Ross recounts the enchanting story of how, in 1954, he, using an ingenious programme he had written, made what may be the first computer drawing in history by writing his own name with his finger on an oscilloscope screen attached to the *Whirlwind I* computer. In [HMGR+89], the early work on graphical displays connected to the *Whirlwind,* starting already back in 1948/1949, is outlined. Cf. also [HMTR+89]. The *RAND tablet* made pen-based input available in the early 60s, and the *GRAIL* programme devised for it by Tom Ellis provided support for gesture recognition. The 60s also gave birth to the joystick and the mouse. See [Kay93] p. 73 and [Myer96].

580 The constraint idea, which was picked up in Borning's *ThingLab,* described in [Born81], has become a popular subject of research.

581 [Shne83] is the seminal work on *direct manipulation.*

582 [Suth63a] p. 138

583 [John63]

584 *Sketchpad* provided two tiled zooming windows, Cheadle's and Kay's *FLEX Machine* multiple tiled zooming windows (see [Kay69] p. 235 et seqq.), whereas Engelbart's *NLS (oN-Line System)* supported multiple tiled scrolling windows. Kay vaguely hinted at the possibility of overlapping windows in his thesis ([Kay69] loc. cit.). The *FLEX Machine* had primitive icons, which represented programmes and data,

Xerox PARC in the early 70s that the modern graphical user interface was born. The *PARC* endeavour expanded and synthesised the ideas of the late 60s into a grand vision of "object-orientation", where the "personal computer" was turned into a "pocket universe"[585] inhabited by objects, "a society of objects"[586], as it were. The importance of this grand synthesis of ideas cannot be exaggerated – it shaped almost all aspects of the current style of *GUI*-based personal computing.

The *Smalltalk* system, originally developed by Alan Kay and the *Learning Research Group* for the *Xerox Alto* machine, pioneered the idea of a bitmapped display used as a workspace, shared between programmes through multiple overlapping windows capable of displaying rich text, graphics, and animations, and operated by the user through pop-up menus[587] and mouse- or keyboard-based direct manipulation techniques.[588] Additionally, the conception of the *GUI* as event-driven and reactive was now established and was eventually refined into *Smalltalk's Model-View-Controller (MVC)* architecture, devised by Tryggve Reenskaug at *PARC* in the late 70s. Other important developments made at *PARC* at about this time included the use of (textual) icons for programming in David Canfield Smith's *Pygmalion* and the use of (pictorial) icons as stand-ins for collapsed windows in the *Tajo* programming environment, the cut-and-paste editing model developed by Larry Tesler, and the construction of numerous archetypal graphical applications for text editing, word processing, painting, drawing, office workflow, etc.[589] Important hardware achievements included the *Alto* personal computer, the *Ethernet* local area network, the laser printer, and the *Notetaker* portable computer.[590]

The commercialisation of the *PARC GUI* started with the *Xerox Star* in 1981[591] and the *Apple Lisa* in 1983[592], neither of which was particularly successful in terms of sales returns – largely a consequence of unrealistic pricing. However, the more moderately priced *Apple Macintosh,* introduced in 1984, became a major success and popularised the idea of a graphical user interface. A plethora of more or less successful *GUI*-based systems followed, the currently most widely used of which is *Microsoft's Windows* in its miscellaneous appearances. Although the *PARC* research community had used *Smalltalk* both as its programming language of choice and as an "integrated environment" on the *Alto* machine, none of the commercial *GUI* systems was *Smalltalk*-based. Instead, procedure-oriented languages thought to be more efficient, such as *C, Mesa,* and *Pascal,* were preferred, and somewhat later "hybrid" object-oriented languages such as *Clascal, Object Pascal, Objective-C,* and *C++* came into more or less widespread use. The *Smalltalk* programming language and environment was separately commercialised by the companies *ParcPlace* and *Digitalk,* but its success in the marketplace has been very limited.

By its pervasive adherence to the *desktop* (or *office) metaphor*[593]*,* the *Xerox Star* pioneered a *document-centric interface,* and the integration of specialised editors for various kinds of data – such as structured graphics, tables, and formulas – into its document editor started the long-lasting quest for *compound documents* – a quest that has been instrumental in the development of distributed object, component, and compound document technologies such as *CORBA, OLE/COM/ActiveX,* and *OpenDoc.*[594] Although the desktop metaphor has been

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and *MIT's AMBIT/G* also supported icons and the selection of icons by pointing. The use of menus was widespread in the on-line systems available in the 60s, and *AMBIT/G* supported dynamic menus and selection through pointing. Pointing was a cornerstone already of *Sketchpad,* where the user directly controlled the cursor through the light pen. See [PV89] and [Myer96].

585 [Kay93] p. 84

586 This term has, somewhat anachronistically, been appropriated from [Toko93].

587 A menu bar of shortcuts to the pop-up menus was introduced in each window by the *Xerox Star,* whereas the *Apple Lisa* located its menu bar at the top of the screen. The latter menu bar was shared between applications and used *pull-down* menus instead of *pop-ups.*

588 See [Lear76], [Kay77], [KG77], [Kay93], and [Tesl81]

589 More details can be garnered from [JRVS+89] p. 20 et seqq.

590 See [PW85] and [Pake85].

591 See [SIKV82], [JRVS+89], [PW85], [MJ96] and [Lidd96].

592 See [PKL97] and [MWL83].

593 A variant of the desktop metaphor was present already in the *Spatial Data Management System* devised in the late 70s by Nicholas Negroponte and the *Architecture Machine* group at *MIT.* See [Bran87] p. 138 et seqq.

594 Cf. [Wats96a]

extremely influential[595], most subsequent systems do not adhere to it as faithfully as the *Xerox Star,* but compromise it in various ways, in particular by foisting the *tools metaphor* and thereby adopting a basically *application-centric* approach rather than a *data-centric* or *document-centric* one. Thus most graphical user interfaces do not hide applications from end-users, but let users work with these directly as "tools", whereas the *Star* attempted to conceal applications entirely and make users manipulate data and documents only.[596] For a long time, there has, however, been a strong trend towards more data- and document-centric approaches. This trend is manifest in *IBM's CUA (Common User Access)* and *OS/2 Workplace Shell* as well as in the user interface of recent versions of *Microsoft Windows*. Notably, *CUA* and the *OS/2* user interface wielded considerable influence on Oliver Sims' vision of business objects, and the principle of direct manipulation of data items – rather than of application programmes – is a quintessential ingredient of the business object programme.

Barring various minor improvements such as pull-down and tear-off menus and button toolbars, today's state-of the art commercial *GUIs* are basically equivalent to the anno 1981 *Xerox Star* interface.[597] The most significant innovation will be the recent inclusion of web-content such as hyperlinks and channel data into documents, windows, and the desktop in *Microsoft's Internet Explorer 4.0* and *Windows 98* and in *Apple's* now defunct *OpenDoc*-based *Cyberdog* web browser. In a later section, I will discuss the appearances of the user interface of the future.[598]

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[595] The *Xerox Star* interface provided the inspiration for the desktop manager of *Apple Lisa* and, hence, indirectly for the *Macintosh, Windows,* and most other desktop-imitating user interfaces. See [MWL83] p. 108 and [PKL97].

[596] [JRVS+89] p. 13 et seqq.

[597] An interesting attempt to further and deepen the desktop metaphor was *Wang's Freestyle,* released in 1988 and running on top of *MS-DOS* on an ordinary PC. This neatly designed imaging system made extensive use of, at least for its time, advanced multimedia technology and elegantly wove scanners, faxes, "electronic paper" (a tablet with a stylus), and voice input into the fabric of the desktop metaphor. A user could make voice and pen annotations directly in documents, send voice messages as mail to other *Freestyle* users, and staple and unstaple piles of documents (displayed on the desktop as "miniatures" or "stamps" rather than as icons). Multimedia equipment has since increasingly become mainstream technology, although the tight integration, usability, and coherence of the *Freestyle* user interface are still impressive. See [PBWE89], [FRCL91], [LE91], [Fran96], and [BGBS95] p. 867 et seqq. [Well93] describes *DigitalDesk,* a research project at *Xerox's EuroPARC* establishment, where computer-support is introduced into the physical desktop through the ingenious use of cameras and projectors in order to achieve "computer-based interaction with paper documents". *Siemens' PClamp,* mentioned in [Olan98], seems to be a similar development. [Sand95a] reviews a more modest attempt to improve on the desktop metaphor, made by the small Swedish company *RTB Program,* whose word processor *Cicero* replaced the ordinary files, directories, and drives of the *Windows* desktop with its own set of metaphors – entrances, bookcases, binders, and flaps.

[598] See below p. 259. See also [Pers99c] and [Pers00a].

1.2.3 THE BUSINESS ELEMENT – BUSINESS ENGINEERING AND *BPR*

Some practitioners of *business process reengineering (BPR)* – also known as *business engineering* – use object-oriented techniques to model and reshape organisations.[599] In this context, the term *business object* is frequently used to signify the business-related entities that constitute the parts of the *business models* worked on.[600] These *business objects* are sheer modelling constructs, although they may optionally be implemented by software that supports the business processes of the reengineered enterprise. Indeed, software systems built from such business objects may be expected to adapt to changes in the business model more easily and gracefully than traditional systems and thus fulfil the need for *agile systems* occasioned by these methods of rapid and constant change and reengineering.

Since around 1990 Robert Shelton of *Open Engineering, Inc.* has promoted and refined *Object-Oriented Business Engineering™ (OOBE™),* a method for *business modelling* and the mapping of business models into software.[601] He criticises traditional object modelling for looking at the business "only through the eyes of software development" and for only delivering "stovepipe applications", i.e. object-oriented variants of traditional monolithic software.[602] In contrast, *business modelling,* he claims, emphasises the viewpoint of the business itself and delivers a "web of interacting peer-to-peer servers" or *business objects* in lieu of the inflexible monolithic stovepipe structures.[603] Simply put, *OOBE* is a method for the discovery and design of such *business objects.*

Shelton makes ample use of the term *business object,* which in his diction signifies both the modelling abstractions that represent various *business concepts* and their software counterparts. The latter should be useful across application boundaries to qualify as *business objects.* Additionally, he differentiates *business objects* from *technology objects,* which are programming-related objects such as linked lists, trees, etc, and from *application objects,* which are objects useful only within a certain application.[604]

Three different kinds of *business objects* are recognised by Shelton: *entity, process,* and *event business objects. Entity objects* represent the nouns of the business model – persons, things, organisations and the like –, whereas *process objects* represent the verbs and encapsulate *business processes* or *workflows,* which model various interactions between business objects. The *entity objects* are also thought of in terms of "actors" or "role-players" active in the *business processes. Event objects* represent *business events,* i.e. the changes, actions, etc. that may take place in the

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599 The *BPR* ideas were first proposed by Hammer and Davenport. [DS90] and [Hamm90] are the seminal articles, [Dave93] and [HC93] the seminal books of the *BPR* movement. The simple basic idea of *BPR* is that organisations need to radically reassess – "reengineer" – their business processes in order to bring about the dramatic improvements needed to remain competitive in an age of continual change. Traditionally, business improvement efforts have tended to be task-centred, using e.g. automation and Taylorist time studies to emend the individual tasks of a business process. In contrast, *BPR* aims at the reengineering of whole *business processes* by obliterating unnecessary tasks, combining and reordering others, making information flow to all employees who need it, etc. Cf. also [HS95], and [Hamm97].

The popularity of *BPR* has declined rapidly as a consequence of its very high failure rates – [Dave95] cites a *CSC Index* survey of 99 *BPR* projects, out of which 67% failed or showed mediocre results, and [Suth95b] p. 274 states that around 80% of all *BPR* attempts have failed. According to [Dave95], the afterthoughts of the *BPR* pioneer Davenport, *BPR* efforts often came to disguise cost cuts necessitated by the economic recession during the heyday of *BPR* and largely became synonymous with massive lay-offs, which created fear and uncertainty among staff, defection of key personnel, and the laceration of the social fabric of companies. Be that as it may, when the bad days arrive, organisations, which during better days have become bloated, flabby, lackadaisical, or bureaucratic, have to do something in order to survive, reduce costs, and boost productivity. [Stra95] points out that the basic principles of *BPR* have been formally practised at least since the 1920's under the lack-lustre label "Methods and Procedure Analysis". Cf. also [Stra94].

600 These models are sometimes also referred to as *enterprise models.* [Grah95] p. 220 makes a distinction between four kinds of *object modelling,* viz. *strategic* or *enterprise modelling,* which "covers enterprise and business process modelling, requirements capture, and development planning", *analysis* or *business object modelling,* which "covers the process of obtaining and recording a description of the problem domain", *design modelling* or *logical design,* which "consists in adding non-public information to class specifications and producing a solution to some particular problem including system and interface objects", and *implementation modelling,* which "is physical design and involves designing modules, the distribution strategy and taking account of the specific software and hardware to be used". Various business modelling approaches are surveyed in [Chou99] p. 34 et seqq.

601 In [Shel93], he called his method *Object-Oriented Enterprise Modeling (OOEM)* instead. He has published his views on *business objects* in numerous articles – [Shel93], [Shel94a-b], [Shel95a-n], [Shel96a-c], and [Shel97] – and is planning a book as well. See also [Open99a], [Open99a-b], [Open00], [SS01], [FRS96] p. 217 et seqq., and http://www.openeng.com, the web site of *Open Engineering.*

602 In [Bann01], the stovepipe problem is also referred to as the "silo" problem.

603 [Shel95f]

604 In [Shel93], he uses the term *foundation objects* instead of *technology objects.* See also footnote 520 on p. 118 above.

system. Examples of *entity objects* include "customer", "product", or "order", whereas typical *process objects* will be "order fulfilment" and "payment collection" and *event objects* may be circumstances such as "demand exceeds resources" or "end of fiscal year".[605] Technically, *business objects* may be implemented by, for example, *CORBA* objects or by *COM/ActiveX* components written in *C++* or some other programming language.[606]

Shelton's ideas have been quite influential on the *business objects* activities of *OMG,* which he instigated and headed in their initial phase, and he is still playing a very active rôle in this work.[607] Possibly, he was the first to use the term *business object* in the sense we now understand it[608], and he also expeditiously combined his own *OOBE* method with the *BPR* ideas, when these came into vogue.[609]

The well-known object theorist Ivar Jacobson has developed another variant of the object-oriented *BPR* theme, somewhat oddly named *object-oriented business engineering* just like Shelton's trademarked method.[610] Jacobson bases his method on his own modelling ideas and notations, including *use case* models and *interface, control,* and *entity objects* as the basic modelling constructs.[611]

However, Jacobson does not make much use of the term *business object.* One exception can be found in a short section in his *BPR* book on a "four-layered business model", where one of the layers is built from what he calls *common business objects.*[612] These are defined as "objects generic to the type of business modelled" and are supposed to be "used by many different businesses or business system areas within the company modelled". Examples of common business objects for a bank would be "customer, account, loan, branch office". In Jacobson's book on software reuse, another four-layered architecture is presented, which, however, is quite different from the "four-layered business model" just mentioned. In a section on the "business-specific layer" of this model, he dwells somewhat more extensively on business objects, which he defines "as representing something concrete and significant in the business", and attempts to determine their rôle in his own *Reuse-Driven Software Engineering (RSEB)* method.[613]

A third business engineering method called *convergent engineering* has been devised by David Taylor, an author and columnist writing on object-orientation from a business perspective.[614] Taylor advocates *model-based*

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605 [Shel96a]

606 [Shel96b]

607 See [OMG93] and [Open93]. He has also been chair of the *CBO (Common Business Object) Working Group* of the *BODTF.*

608 See footnote 465 on p. 109 above. At about the same time, Gessford came up with ideas that parallel Shelton's thinking in some respects, although there are also significant differences. In Gessford's scheme, an E-R diagram is used for the identification of the business objects. Characteristically, the *business objects* are distinguished from other kinds of objects, such as "application system objects, software system objects and hardware objects", which usually come with the development system. Interestingly, he also discerns three types of business objects: long-lived "permanent business objects", short-lived "business event objects", and "dependent business objects", the life span of which depends on that of other objects. See [Gess92] for more details. Cf. also [Gess91] p. 398 et seqq. and [Gess97]. Notably, Brad Cox' ideas about objects as *Software-ICs* (see below p. 137) put forward in the mid-80s naturally lead to the notion of standardised business-oriented domain objects, as can be seen from e.g. [Mikk91].

609 [Shel94a-b]

610 [JEJ94]. Cf. also [JGJ97] p. 32 et seq. and p. 213 et seqq. [Grah95] is also much concerned with *BPR* – see p. 319 et seqq. and passim. Some other passages touching upon the possibility of integration of *BPR* and object-oriented methods are found in [GR95] p. 23 et seq., [GHY97] p. 85 et seqq., [Suth95b], and [ES98] p. 3. [Prin96] p. 41 et seqq. uses the term *business transformation* instead of *BPR* and refers to Boynton and Pine's ideas on *mass customisation* rather than to Davenport's and Hammer's writings, but his line of argument is similar.

611 See [JCJÖ92] p. 126 et seqq. for a detailed account of these concepts. Jacobson's *entity objects* model long-lived information items, whereas the *interface objects* pertain to all kinds of interfaces to the system, and the *control objects* encapsulate functionality that does not belong to any particular object, such as operations involving many entity objects. This proliferation of object types aims at robustness against change – the *control objects* will encapsulate most aspects prone to change, whereas the *entity objects,* liberated of these changeable aspects, should be comparatively immune to modifications – and more reusable as well. Clearly, *entity objects* are closely related to *business objects.*

612 [JEJ94] p. 331 et seqq.

613 [JGJ97] p. 186 et seqq. He here refers to the *OMG BOMSIG* initiative as well as to various earlier works by Shelton, Taylor, Sims, and by himself. [Hung96] p. 2 mentions some other uses of the term *business object* Jacobson reportedly made at a tutorial at *OOPSLA '96.*

614 [Tayl95a]

development, i.e. the direct representation of business structures in software[615], and uses *object-based business modelling* to create a model of the business, the elements of which he variously refers to as *business objects, business elements,* or simply *objects.*

In his writings on *SOMA (Semantic Object Modelling Approach),* Ian Graham advocates a similar approach, which largely has been adopted also in the eclectic *OPEN (Object-Oriented Process, Environment and Notation)* method.[616] In the *OPEN* incarnation of this approach, there are four different models: *TOM (Task Object Model), BOM (Business Object Model), SOM (System Object Model),* and *IOM (Implementation Object Model).* The task objects are a kind of "generic use cases", from which the business objects of the *BOM* are identified by, for example, noun/verb analysis. By adding "systems knowledge", the *BOM* is transformed into a *SOM*[617]*,* which is then implemented in a programming language by the *IOM.* Business object models may also be executable, if certain tools are taken advantage of, although such executable *BOMs* should not be mistaken for real implementations – they are rather "executable specifications".

Another variation on the enterprise modelling theme is Chris Marshall's *BOMA (Business Object Management Architecture),* which focuses the modelling efforts around a small number of fundamental *business concepts – purpose, process, resource* (or *entity),* and *organization –,* which together form an *enterprise meta-model.*[618] The business *purpose* is the "vision, missions, goals and objectives" of an enterprise, the *processes* explain how the purpose is to be realised through a number of *process steps*, *resources* model "human, material, energy and information resources consumed and produced by an organization", and *organizations* provide the institutional framework for the other concepts. The *UML stereotype* extension mechanism is taken advantage of in order to introduce special symbols for these four basic business concepts to be used in *UML* compliant diagrams. *BOMA* also provides a support framework written in *Java,* which facilitates the implementation of the *business objects* (i.e. *purpose, process, resource,* and *organization* objects) of the enterprise model (or *semantic object model)* as a three-tier client/server *Java* system. Many of the implementation tasks, including database design and access, transaction handling, and user interface design, are automated.

In their book on *UML*- and patterns-based *business modelling,* Hans-Erik Eriksson and Magnus Penker make a distinction between two kinds of *resources,* viz. *things,* which may be either *physical* entities (including *people)* or *abstract* ones, such as "contracts, roles, accounts, and energy", and *information objects,* which hold information about other *resources* and act as "surrogates" for these, e.g. in an information system.[619] In actual software systems, an *information object* is implemented by an *entity object,* which typically holds various pieces of information stored in a database and constitutes one of three kinds of *business objects*. The other two categories of *business objects* are *business process supporting objects,* which "run and track the execution" of a process, and *business event objects,* which are used to trigger actions in reactive objects. In addition to *business objects,* there are various technology objects, including the *boundary objects* that implement the interface to the system. Although this scheme seems similar to Shelton's (and, thus, to that of *BOMSIG),* the distinction between *things* and *information objects* will be a novelty.

In a *BPR – Business Process Reengineering* – context, *business processes* evidently ought to play a central rôle. In an interesting paper, Schmid and Simonazzi argue that in actuality "business application structures and frameworks" do not provide adequate support for the modelling and representation of *business processes.*[620] They discuss a number of concepts, which in their view need to be represented in implementations by special *business objects* in a way that reflects how the business community thinks and talks:

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[615] Another plea for *model-based development* can be found in [Digr95] p. 158 et seqq. A related term occasionally encountered is *model-driven development,* which, however, tends to be primarily used to designate a modelling approach that is based on visual object/process modelling tools and automatic code generation from the graphical models built with such tools, although the usage of both terms is vacillating and indistinct. Cf. also the *model-oriented* approach described above on p. 122.

[616] See [Grah95] p. 278 et seqq. and p. 320 et seqq. The more recent *OPEN* variant is presented in [GHY97] p. 52 et seqq., p. 89 et seqq. and p. 290 et seqq. Cf. also [Grah97], [HSY98], and [FHG98].

[617] This intermediary model was not present in [Grah95] and is sometimes skipped also in [GHY97].

[618] See [Mars97b], [Mars98], and [Mars00].

[619] [EP00] p. 76 et seqq. and p. 379 et seqq.

[620] [SS98a]. Cf. also [Schm99a].

- A *business process* consists of a sequence of "business procedures".
- A *business procedure* is triggered by an external event, such as the arrival of a message. It consists of a sequence of "business activities", and it will be visually represented by a modal dialogue. Examples of business procedures are "change a customer address" or "cancel a health insurance".
- In contrast to a business procedure, a *business activity* is usually triggered by the termination of a previous business activity. Also in contrast to a business procedure, it is an atomic unit of work, which is performed either as a whole or not at all. Typical business activities are "change customer's address record" or "check if cancel notice is valid". An activity may consist of any number of "business subactivities", and it will be visually represented by a modal dialogue.
- A *business subactivity* is the most fine-grained building block in this scheme. It may be an action, such as "search the customer" or "select a customer from the search result". In contrast to a business activity, a subactivity is not atomic, is usually represented by a single (non-modal) screen or dialogue box, and is driven by user input.

A *business procedure* can be represented by a *business activity tree* of specialised *business objects,* viz. the *business procedure* itself as root, *business activities* as intermediary nodes, and *business subactivities* as leaves. Regular *business objects* or *business entities* are created, accessed, and invoked by *business activities* and *subactivities.* In the implementation of such a tree, each node will have a view component that presents it to the user, as its start-method is called during the execution of the tree.

In his Ph.D. thesis from 1999, which by the way also provides a survey of much of the earlier work done on business modelling, Islam Choudhury sets out to develop yet another business object modelling method, which he calls *GRBOM (Generic Reusable Business Object Modelling),* on the basis of general systems theory, trying to overcome the gap between process-oriented business modelling and data-oriented information systems modelling by the reliance on the same object-oriented modelling constructs in both activities.[621] In particular, Choudhury argues that business processes are to be represented as objects, or rather "transformed" into objects by a special method. He also distinguishes three "abstraction levels" applicable both to business modelling and information systems modelling, viz. the *conceptual, representational,* and *instance level,* of which the first provides very general concepts about the world and the business concerned (such as "actor", "resource", "event", "process", etc.), the second is concerned with typical domain modelling concepts (such as "customer", "order", "address", etc.), and the third pertains to applications (such as "order processing system", "billing system", etc.).

In another British Ph.D. thesis dating from 1999, Kitty Hung of the University of Sheffield presents the *DBOA (Dynamic Business Object Architecture),* a method specially designed so as to support the implementation of strategic business plans on the basis of various theories about *strategic management planning (SMP).* In essence, the *DBOA* method is an adaptation of the existing *Dynamic System Development Method (DSDM)* to a business object architecture moulded on the proposed *OMG BODTF* specification.[622] In *DBOA,* four levels of a business object model are discerned, to wit the *business strategy level,* the *business process level,* the *object-oriented modelling level,* and the *database management system level.*

The above *business modelling* variants clearly have much in common, although, apparently, business object modelling can be varied ad infinitum. For one thing, they do not care very much about the technical and implementation aspects of *business objects,* but are primarily concerned with modelling – and organisational and management issues. They all have their roots in object-oriented modelling and, in some cases, in full-blown object-oriented methods, but adapt object modelling to the needs of *BPR* and other high-level approaches.[623]

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621 [Chou99]

622 [Hung99]

623 For instance, Robert Shelton advocates the use of the Zachman framework, whereas [EP00] adopt a scheme of four "business views". Many other business analysts now work with the *ISO* standard/*ITU* recommendation *RM-ODP (Reference Model of Open Distributed Processing)* and its *viewpoints.* See [Mill98a], [KKZ00], [OMG98c] p. 19 et seqq. and [OMG97s] p. 11 et seq. for some suggestions about the relation of *business objects* to these approaches. Other high-level architectural frameworks are suggested in [HBPP95], [MN96], and [RZ98].

The *business modelling* methods are closely related not only to each other, but also to the discipline of *domain analysis,* which was developed by James Neighbors in the late 70s during the work with the *Draco automatic programming* system.[624] In *Draco, domain analysis* was used as a foundation for the construction of component-based domain specific languages.[625] From specifications written in such domain languages, executable programmes could be automatically generated by *Draco* with some assistance from the user. Along more or less similar lines, much research on *automatic programming* was going on at this time. None of these *automatic programming* systems were, however, object-oriented – the *components* of *Draco* were, for instance, ordinary subroutines, not objects.

1.2.4 CLIENT/SERVER AND DISTRIBUTED OBJECT TECHNOLOGY

The ubiquity of personal computers that share data through corporate or departmental database servers has made the client/server architecture the cornerstone of the enterprise computing practices of the 90s. When designing a client/server system, the system architect is challenged with a wealth of critical and difficult choices between, for example, different: [626]

- schemes of system partitioning (2-, 3-, n-tier)
- client and server platforms
- tools, environments and languages
- middleware products
- network architectures and protocols
- types (relational, object-oriented, etc.) and makes of database management systems
- techniques and technologies of shared data access
- transaction handling mechanisms
- security policies

In addition to the above, many other design issues most probably will have to be considered as well. Currently, the trend is to realign client/server technology for execution over the *Internet* or an intranet.[627] Subtly interwoven with this tendency is another one towards the use of distributed object technologies in client/server systems, and *CORBA* or *DCOM* distributed objects are often thought of as appropriate impersonators of *business objects*.[628] In any case, client/server and, in particular, distributed objects technology form the hinterland, from which business objects have marched to war.

Cf. also [CSP97], [CP97], and [CP99]. *RM-ODP* is documented in [ISO96b-c] and [ISO98a-b]. The seminal papers on the Zachman framework were [Zach87] and [SZ92].

624 [Aran89] includes a very short summary of the history and development of *domain analysis,* whereas [Bigg97] surveys the rôle of generative techniques for reuse. Cf. also [RW92].

625 *Draco* is described in detail in Neighbors' doctoral dissertation [Neig80]. Shorter descriptions are available in [Neig83], [Neig89], [Free84], and [Free87b], whereas [NAL84] provides a user's manual for *Draco 1.3*. Cf. also [ABFP86] and [HM83] p. 255 et seq., where also some concerns about the *Draco* approach are aired.

626 There is a rich literature on client/server architectures. For example, [Bers96] is a solid textbook on most aspects of "traditional" client/server technology, while [Gunt95] focuses on *RPC* and *DCE* programming. [Ligo97] and [OHE99] ([OHE96a] is an earlier edition) also provide comprehensive treatments of the subject. [Edwa97a] presents a number of case studies of 3-tier client/server systems, and in [Vask95] David Vaskevitch, vice president of *Microsoft's* distributed applications platform division, surveys the client/server area from a "strategic" viewpoint. Unfortunately, the staggering progress of the state of the art in client/server technology makes many books seem dated already when they appear in print.

627 Some books geared towards *Internet* client/server technology are [BenN97], [BenN98], [Umar97], [HS98c], [SE98], [Zaha00], and [BBCE+00]. See also below p. 535.

628 [OHE96b], [OHE99], and [Emme00] provide a general treatment of distributed object technology in client/server computing, although with a strong *CORBA* bias; [Lewa98] is an *ACM Computing Surveys* article with an even stronger *CORBA* tendency. [Sera99] provides a concise textbook on "middleware". [Grim97], [Redm97], [Lhot97], [Lhot98], [EE98a], [Sess98a], [HS98b], [Patt98b], [Pinn98], [Moni99], [Sess00b], [Chap00], and [DDLN+02] deal with *Microsoft's* enterprise architecture or aspects thereof. [BenN97], [BenN98],

Amongst the various *business object* ideas and visions floating around, that of Oliver Sims will be the most radical as well as the most thoroughly worked out one, being founded upon the firm ground of an implementation, the *New World Infrastructure (Newi),* used in real functional systems. The starting point of Sims' groundbreaking re-interpretation of the ideas of object-orientation is the omnipresent problem of how to design client/server systems that interconnect *GUI* clients with relational database servers. Although Sims and the *Newi* system have had some influence, for example on Prins and the indefatigable author trio Orfali, Harkey, and Edwards, they have, however, largely been ignored.[629] A detailed account of Sims' ideas will follow below.

Almost all authors writing on *business objects* consider client/server systems a primary target of their designs, even though the problems of client/server design are seldom given the kind of detailed technical attention found in Sims' writings.[630] Since its inception in 1994, the *OMG BOMSIG/BODTF* effort has been a focal point for much of the interest in *business objects.* This work originally set out to define a *Business Object Facility (BOF),* i.e. a client/server infrastructure for *business objects,* but came to shift emphasis towards issues of specification and modelling, although an "interoperability framework" attempted to address some of the technical aspects of client/server computing. The *BODTF* effort will be treated of at length below.[631] Also *Microsoft's* conception of business objects is part of a client/server scheme that will be discussed below.[632]

1.2.5 SOFTWARE COMPONENTS

As we saw in the initial chapter of this study, the notion that software could – and should – be built from prefabricated components in a manner similar to hardware is a very old one, going back at least to McIlroy's famous invited address *Mass Produced Software Components,* delivered at the *NATO* conference on software engineering in Garmisch in 1968.[633] The origin of the modern component concept is, however, arguably Brad Cox' *Software-ICs,* i.e. binary packaged objects possessing the dynamic properties now widely believed to be characteristic of a component.[634] Cox' writings and ideas have had considerable influence on some business object authors, although it is difficult to fathom the exact width and depth of this influence.[635] There is a fundamental, albeit not always noted, clash in outlook between *object-orientation* and *software componentry,* of which the former is based on the notion of hierarchical modelling of exemplars, the latter on the idea that software should be composed from reusable parts. So, whereas the former is grounded in the modelling concept of inheritance, the latter rests firmly on the principle of the encapsulation of parts, and, as we shall see later, it turns out that the combination of these two notions is a far cry from problem-free.[636]

The latter part of the 1990s saw a growing disappointment with object-oriented programming as the cure-all of the woes of the "software crisis" it was once widely held to become – at least by its more ardent adherents. This disappointment turned into a rather widespread scepticism of "object-orientation" as a phenomenon, and the term *object-oriented* has even gained the status of a derogatory byword in some circles.[637] At the

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[Hoqu98], [SGR99], and [Zaha00] are some titles that treat of *OMG's CORBA* in the context of web and client/server programming. [SWJ97], [Berg98], [FFCM99], [AW99], [Roma99b], [VR99], and [DDS02] are about *Java Enterprise,* [OH98] discusses client/server programming with *Java* and *CORBA,* and [CH98] focuses on *XML* and *Java.*

[629] [Prin96] p. 277. [OHE96b] p. 325 et seqq.

[630] Exceptions exist, such as [Lhot97] and [Lhot98], who provide a very thorough treatment of how business objects may be implemented in a client/server system by the use of *Microsoft's Visual Basic 5.0/6.0* and various other *Microsoft* technologies. See below p. 212.

[631] See p. 177 below.

[632] See p. 210 below.

[633] [McIl68]. See above p. 28.

[634] See p. 35 above.

[635] Cox' book *Object-Oriented Programming – An Evolutionary Approach* (the first edition, [Cox86], as well as the second, [CN91]) is rather frequently cited in the business object literature. Its influence is clearly palpable in, for example, [Digr95], [Suth95a], and [Sims94] (see p. 138 et seqq.), and, to a lesser degree, in [Prins96] (see p. 116 et seqq. and p. 161 et seqq.). Its main importance for the *business objects* field will be as the source of the notion of *surface area,* the reduction of which is often viewed as an overriding goal of business objects, whereas the *Software-IC* idea has had a much more indistinct influence. Cf. footnote 722 on p. 152 below.

[636] See below p. 230.

[637] See below p. 228.

same time, a sentiment caught on that "visual" component-based *RAD (Rapid Application Development)* environments, as typified by *Visual Basic* and its *VBX, OCX, ActiveX,* and now *.NET* controls, had already enhanced programmer productivity far beyond what was customary, when working in the code-intense object-oriented programming style, the archetype of which will be a bloated *C++* programme, replete with obscure low-level programme code that deals with presentation, data base access, and other aspects of systems programming at great length, and had to be written and maintained by a priesthood of highly skilled, specialised, and salaried engineers, who had spent years learning how to master the complex *APIs,* frameworks, and tools they use.

This shift in opinion was also reflected in the *business object* territory, where there was a strong tendency towards thinking of business objects in terms of components rather than objects. The component trend was reflected by, for example, the naming of *BOCA – Business Object Component Architecture* – for the final *BODTF* proposal and Eeles', Sims', and Herzum's adoption of terms like *distributable/distributed component* and *business component.*[638] The component idea has, however, been brought to bear on business objects late and does not fit together organically with the business object vision. In most cases where it is taken advantage of, it actually appears either as an inept afterthought or as an attempt to redefine business objects into *ActiveX-* or *JavaBeans-*like components. It may be argued that the discord between the component and the business object perspective has created considerable confusion, as may, for instance, be appreciated from the discussions in *OMG's BOMSIG* mailing list. The interpretation of business objects as "ultimate components", pioneered by Orfali, Harkey, and Edwards, seems to paper over the fundamental difference in attitude that exists between the business object vision of a microcosm of loosely coupled, independently *executing,* plug-and-play objects and the component vision of independently *built* parts soldered together into applications in a way similar to the way hardware devices and other machinery are assembled.

The currently very intense interest in *COM+/Microsoft Transaction Server (MTS)* and *JavaBeans/Enterprise JavaBeans* as middleware component platforms raises the question of how these technologies intersect with the territory of *business objects.* May *Enterprise JavaBeans* and *MTS*-based *COM+* components be business objects? Or will they render *business objects* obsolete? So far, *Microsoft* has been remarkably reticent on *business objects.*[639] Within *OMG,* there has been much activity aiming at the reconciliation of *JavaBeans/Enterprise JavaBeans (EJB)* components, the *CORBA* distributed objects specification *cum* services and facilities[640], and the proposed and later retracted business object specification.[641] Undoubtedly, some of the opposition to the business objects proposal among *OMG* members emanated from a belief that it would clash with or at least complicate a forthcoming synthesis of *CORBA* and *JavaBeans.* In our view, *COM/ActiveX, .NET,* and *JavaBeans* are to be understood as enabling infrastructures, which possibly may be used to good advantage for the task of building a business object facility, without themselves being business object facilities. We do recognise the need for a better understanding of the potential clashes stemming from the differences between the component and object outlook – in fact, we will discussed this topic at some length below.[642]

1.2.6 OTHER INFLUENCES

Some authors, as for example John Dodd, Tom Digre, and Jeff Sutherland, have looked upon *business objects* from a *CASE* or *4GL* tool perspective.[643] In particular, this point of view was quite influential on the *OMG BODTF* work, where component assembly tools based on the would-be *Business Object Facility* have been a popular topic of discourse and speculation. Obviously, the *CASE* perspective tends to agree better with a business *component* than a pure business *object* view, as *CASE* tools may easily be envisioned to support the assembly of components, but have a much more foggy rôle in a world of independent business objects. Thus,

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[638] [ES98]. See also [HS98a] and [HS00].

[639] See below p. 210 et seqq.

[640] Cf. [OH98] p. 28 et seqq. The harmonised synthesis of these technologies is often referred to as *CORBAbeans.* The *EJB*-compatible, but language-independent *CORBA Component Model (CCM)* specification – considered the cornerstone of *CORBA 3.0* – was formally approved in November 1999 by *OMG* and received the *MOG* hallmark of "formal documentation" in June 2002. See [OMG02b].

[641] [OMG97t]

[642] See p. 228 below. Cf. also [Pers99d].

[643] See [Dodd94], [Digr95], and [Suth95b] p. 275. [SLJR94] contains papers from two seminars on business objects organised by the *CASE Specialist Group* of the *British Computer Society.* Cf. also [RC95], [JY96], and [Mars97b].

proponents of *CASE* technology tend to transform the business object vision into a business component one, as also happened in the *BODTF* effort.

Of course, many areas in addition to those already mentioned may have influenced some authors' or groups' understanding of the *business object* concept or have the potential of interesting synergy effects, when combined with the *business object* idea. Such "areas of interest" include various Internet-related technologies[644], workflow systems and infrastructures[645], semantic interoperability (e.g. through tagging languages such as *XML)*[646]*,* object-oriented databases[647], transaction handling[648], patterns[649], *Enterprise Resource Planning (ERP,* also referred to as *Business Information Systems),*[650] wrapping or re-engineering of legacy software[651], and miscellaneous AI-related technologies, such as ontologies[652], electronic negotiation[653], agents[654], robotics[655], rule-based systems[656], intelligent visual databases[657], theories on complex adaptive systems[658], and numerous other topics as well. As any attempt to cover all these chequered filiations and relations of *business objects* in full would by necessity run the risk of either sprawling profligately in all directions and beyond all bounds or degenerating into a few utterly scattershot perambulations, we will now cut loose from such topics and instead try to catch *business objects* on the wing, as it were, by looking into some actual endeavours to bring these strange animals to life.

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644 See [Suth97a-b], [BS96b], [Mars97b], [AS99], [SY99], and [PEF01].

645 See [SBM96], [Bake96a], [JY96], [Schr96a], [MN96], [Beed97], [PPC97], [Schu97], [KB98], [Schm98], [Hrub98], [Schr98], [Schm99b], [Maam99], [Rost99], [FK99], [HW00], [MRST+00], [SGW01], and [WH02]. See also http://www.aiim.org/wfmc/mainframe.htm, the web site of the workflow management coalition.

646 See [Koss95], [PA95], [SLML+00], [EHNV00], [Dubr00], [HM00], and [LS01b].

647 See [Merk96], [Tayl98d], and [Wade98]. [SSP97] discuss *temporal object-oriented databases* and *business objects*.

648 See [MRST+00] and [FMMS00].

649 See [Fowl96], [Evit96], [RSEM+97], and [GM95]. Cf. also [FMMS00].

650 See [MN96], [SAP97], [HM00], and [Bann01].

651 See [GS95], [BS96b], [HP99], [MC00], [HMSP+00], and [LS01b].

652 See [Maam99].

653 See [Rebs01] and [LHSB02].

654 See [Bake96a], [Bake97a], [Rost98], [Rost99], [MKK00], and [MS00].

655 [Murr97a] suggests that the "subsumption architecture" used in robotics will be suitable for distributed control of *business objects*.

656 [RSEM+97] p. 20 dispute the usefulness of AI knowledge bases for the specification of *business rules,* which are generally not intended to be used for AI tasks, such as reasoning and making inferences. Additionally, the difficulty of maintaining the integrity of a rule base on modifications, which typically will touch many rules in the rule base in complex ways, is, according to this paper, notorious. Cf. also [RDRE+00] and [Mack00].

657 [Nour01]

658 See [Suth98], [Mars98], [Rost98], [Phil99], and [SH02a-b].

1.3 TOWARDS AN INFRASTRUCTURE FOR BUSINESS OBJECTS

Obviously, a rich infrastructure is required for the *business objects* vision to come to life. The exact nature of such an infrastructure is, however, largely an open question, although there are some widely accepted ideas of which the main building blocks will be. Additionally, the polysemous nature of the *business object* notion will tend to make the lineaments of what is striven for obscure. In this study, our main concern is with *business objects* in the *extended sense,* and, thus, we will primarily attend to infrastructures for this strain of self-contained, independently executable *business objects,* rather than for *business objects* implemented as ordinary language objects or for *business components* wrapped as *COM/ActiveX* or *JavaBeans* components.

In the sections to follow, three different approaches to *business objects* will be investigated[659]:

- the *Newi business objects* platform developed by *Integrated Objects Systems* and the subsequent *SSA BOF* refinement of it (submitted to the *BOMSIG* committee in response to its *BOF RFP* – see next item)
- *OMG's BOMSIG/BODTF* initiative, including the *RFP (Request for Proposal)* for a *business object facility (BOF)* issued by this committee*,* the different proposals submitted in reply to it, and, in particular, the final *CBOF (Combined Business Object Facility),* which was the crowning achievement of this initiative
- some *business objects* approaches based on *Microsoft's DNA (Distributed interNet Architecture)* and *COM (Component Object Model)* technologies, including Rockford Lhotka's *Visual Basic business objects*

Of these, *Newi,* the archetypal *business objects* facility architected by Oliver Sims in the early 90s, has now in effect been discontinued by its owner *SSA,* at least as an actively marketed independent product; the *BODTF* effort foundered in the summer of 1998 after almost five years of labours; and the approaches based on *Microsoft* technology, although certainly viable, are considerably more modest in their goals than such grand schemes as Sims' vision for *cooperative business objects* or the ideas expressed in the *BOMSIG RFP.* Although the expected efflorescence of *business objects* thus neither has happened as yet, nor seems to be in the offing presently, there are some signs that *business objects* may eventually be brought back into kilter as an effect of a number trends and developments now underway, which we will come back to below. In any case, the mentioned technologies proffer important starting points, wayside stations, repositories of ideas and experiences, and food for further contemplation and argument that in all make them well worth a close study and examination. There are also a few other candidates for such a study, which we have chosen not to attend to, most notably:

- the *business objects* strategy of *SAP*
- the *business objects documents (BODs)* of the *Open Application Group Integration Specification (OAGIS)* from *OAG (Open Application Group)*
- *IBM's Java*-based *SanFrancisco* framework

Although *business objects* figure prominently in the discourse surrounding all these approaches, none of them is general enough in scope for our purpose or owes very much to the vision of *business objects* in the *extended* sense that concerns us here. The *raison d'être* of the *SAP* business objects strategy is to provide the *R/3* software package with a wrapper interface of business objects for external software that needs to interact with *R/3,* whereas *OAGIS* is about integration of ordinary applications through *XML* messaging and *SanFrancisco* is a very comprehensive, but rather traditionally designed domain framework written in *Java,* offering support for typical business functionality, such as general ledger or accounts receivable.

It should be noted that we do not consider such *enterprise architectures* as *Microsoft's DNA, Sun's Java 2 Enterprise Edition,* or *OMG's CORBA 3* true *business objects facilities,* at least not in their current garbs, although

[659] Although there are countless technology surveys and comparisons dealing with infrastructures for components *(COM, OpenDoc, JavaBeans),* distributed objects *(DCOM, CORBA, Java RMI),* transaction handling *(COM+/MTS, Enterprise JavaBeans, CORBA OTS),* and the like, very few such studies of *business objects* and *business object facilities* exist. One exception is [Kort97], another [EEOZ98] (summarised in [EE98c]).

they may indeed be used as a foundation for the implementation of such a facility. In many respects, these technologies have actually evolved in the direction needed for the implementation of *BOFs* and may provide good starting points for such efforts, even though they still need to be supplemented in various ways. For example, they may supply mechanisms for:

- distribution
- messaging
- naming
- life cycle operations
- event propagation
- transaction and lock handling
- persistence/database access and externalisation
- meta information and introspective/reflective access
- etc.

Unfortunately, the aforementioned enterprise technologies are known to be both large and complex, and, thus, they will, in raw at least, hardly be very well suited for the business users and business programmers, who are expected to be the primary beneficiaries of *business objects*. I will not attempt here to survey these technologies, to which is already devoted a large and rapidly growing literature – in order to understand the requirements of a *business objects* platform, I have in fact already made a detailed examination of *Microsoft's DNA* in a separate study, included in this thesis as an appendix.[660] Instead, we will now look into, what indeed is germane to our subject in this survey, viz. the characteristics of the three distinct strains of *business objects* of the *Newi, BODTF*, and *Microsoft*-based approaches.

[660] See p. 535 et seqq. below and [Pers99a].

1.4 OLIVER SIMS AND THE VISION OF *COOPERATIVE BUSINESS OBJECTS*

In software development, a distinction can be made between the *programming model,* i.e. the model exposed by the programming language used, and the *programmer's model,* which defines the external *shape* of what the programmer is building, such as, for example, a batch application, an interactive programme, a transaction programme, or a *GUI*-based event-driven application.[661] Whereas the *programming model* answers the question *'How?'*, the *programmer's model* answers the question *'What?'.* Traditionally, cognoscenti as well as catechumens of object-oriented programming have been much concerned with the *programming model,* i.e. how applications are to be built and organised internally, whereas only little attention has been paid to the *programmer's model* or the external *shape* of the applications built. *Cooperative Business Objects* take object-orientation a step further, externalising the ideas of object-orientation from the tenebrous caverns of software *professionals* – analysts and programmers – to the sunny meadows of software *end-users.* In the words of Oliver Sims, the father of much of the current interest in business objects, this is done by "applying object orientation to the *end-product* of the application development process (rather than to components used *within* the process)".[662]

The wide-spread sentiment that traditional monolithic applications are ill-suited for today's *GUI*- or browser-based client/server systems, these being difficult and expensive to build, integrate and reuse, has bestowed some credibility upon the corollary that the *business-sized object* might be a *shape* fitting those systems much better. It seems likely that individually executable *business objects,* implementing concepts familiar to end-users, like *customer, invoice, order, etc.,* may harness the possibilities of current client/server system architectures more fully than the conventional monolithic *application.*

Such business objects must, however, be able to co-operate with other objects that might have been designed and developed independently of them. To achieve such *plug-and-play co-operation,* some interaction mechanism is needed as well as supporting middleware. The interaction must not create intricate inter-dependencies between the objects: What is needed is rather some form of *loose coupling. Business objects* must also exhibit a large degree of flexibility to be able to take part in miscellaneous co-operative efforts.

The *Cooperative Business Object* vision has been vigorously presented by Oliver Sims in his book *Business Objects. Delivering Cooperative Objects for Client-Server*[663] as well as in a number of papers and magazine articles[664] and it is further augmented and developed in *Building Business Objects*[665]*,* co-authored by Peter Eeles and Sims himself. There is a tendency in the latter book to transform the *business object* vision into a *business component* one, which is brought to its logical conclusion in the recent *Business Component Factory*[666]*,* written by Peter Herzum and Sims, insofar as the term "business object" is almost absent here as are some of the basic ideas – notably the reliance on semantic messaging – of the *business object* vision promulgated in the other two works. The business objects vision was originally formed during the design and implementation of the *Newi* system[667], and the further development of thought within the *Newi* team may be inferred from the *SSA* submissions made in response to the *Business Object Facility RFP* of the *OMG Business Object Domain Task Force (BODTF)* and some other *OMG* initiatives.[668]

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661 [SSA97b] p. 5 and [ES98] p. 212. Cf. also [Sims95b] and [Sims96a] p. 42.

662 [Sims94] p. xi

663 [Sims94]

664 [Sims95a-b], [Sims96a-g], [Sims97]

665 [ES98]

666 [HS00]. See also http://www.componentfactory.org. As [HS00] appeared in print just before the completion of this section, I have not been able to fully integrate the views presented in it with my treatment of Sims' ideas below. Since Herzum and Sims here part with so many of the fundamental ideas of the earlier books that they can hardly be said to share in the *business objects* vision any longer and since they here, taking their starting-point not in a particular technology, such as *Newi,* but attempting to embrace the whole gamut of divergent component and distributed objects technologies and trends, tend to be vague on technical matters and to vacillate between different views to boot, this work will anyhow be of less significance than the previous ones for our purpose of looking into *business object* infrastructures.

667 [SSAO96a-b] is the technical documentation of *Newi.* A succinct description of *Newi* is available in [OHE96b] p. 325-338, and [McGi94a] provides a short technical review of it. Cf. also [OMG97k] p. 1–148 et seq. [ES98] came with a CD-ROM, on which a version of *Newi* called *BOF Lite* could be found, and also contained a good account of how to use this software.

668 [SSA97a-c] and [SSA98]

1.4.1 THE *NEWI* SYSTEM

Back in 1988, a small group was formed at *IBM England* in order to investigate "cooperative processing" of PCs and mainframes.[669] During 1990, this group started working on an infrastructure for *Cooperative Business Objects (CBOs)* called *Newi (New World Infrastructure)*[670]. In 1993, *IBM* and the English software house *Softwright* launched the joint venture *Integrated Object Systems* located in Newbury in Berkshire, England, appointing Martin Anderson from *Softwright* managing director and Oliver Sims from *IBM* principal consultant of the new company. *Integrated Object Systems* shipped a first version of *Newi* in May 1994, and this same year Oliver Sims published his first book on *business objects,* which became one of the main sources of inspiration for the wave of interest in *business objects.* Early in 1996, *SSA (System Software Associates),* a world-wide provider of *ERP (Enterprise Resource Planning)* and other information systems mainly to the industrial sector, acquired *Softwright* as well as *Integrated Object Systems,* which was made a branch of *SSA* under the name of *SSA Object Technology.*[671] In late 1998, Sims and his co-workers in Newbury moved from *SSA* to *Metapath Software International (MSI),* and Sims somewhat later became practice director for *Genesis Development Corporation,* a software consulting and services firm specialising in distributed objects and components. Presently he is with the *Cutter Consortium* as a senior consultant.[672]

Figure 10. The Newi Solo 2.3 tools

Newi, albeit not a commercial *succès pyramidal,* was used in a number of real-world projects in areas as diverse as finance, public utilities, and video telephony.[673] It was available for the different *Windows* varieties, *OS/2,* various *UNIX* systems, and *OS/400* and came with a pick of tools, including a class browser, a package browser[674], and a number of debugging and tracing aids (see *Figure 10).* A simple layout editor could be used when designing forms (see *Figure 11).*

Through, among others, Oliver Sims and Martin Anderson, the ideas embodied in *Newi* have become influential also on the work of the *OMG BODTF (Business Object Domain Task Force)* committee and its predecessor *BOMSIG (Business Object Model Special Interest Group).* Additionally, Oliver Sims was a member of the *Architecture Board* of *OMG* in 1996-1998.

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[669] [Sims94] p. xiii et seq.

[670] The background of the name *Newi* is given by [Sims94] p. xiii. In the early days, the members of the *IBM* group, working with a pre-release of *OS/2,* started saying to each other "Hey, this is a new world". In 1989, Oliver Sims, himself a member of this group, picked up this dictum in an internal *IBM* paper entitled *The New World,* and, as a result, the concept *new world* gained the status of a catch phrase within the corridors of *IBM England.* [CCHJ93] recounts some experiences from one of these early *New World* projects and some other object-oriented projects at *IBM.*

[671] See [SSA96] and [Cons96]. Similarly to how *SAP* uses *business objects* as a wrapper interface of *R/3, SSA* uses *Newi* to create *semantic message gateways (SMGs)* interfaces to a *business objects* wrapper of its *eBPCS* manufacturing and *ERP* package. See [Parm98].

[672] See [Sims98], [HS00] p. xix, and http://www.cutter.com/consultants/simso.html. *Genesis* was acquired by *IONA* in 2000.

[673] [Cons96]. [SSA97b] p. 39 stated that *Newi* was at the time in use in over 50 companies. The largest user base within a company was reported to be "well over 500". Cf. also [OHE96b] p. 326 and [SSA97b] p. 44.

[674] In *Newi,* related classes are bundled into a *package* and may then easily be installed together. See [ES98] p. 27 and p. 36.

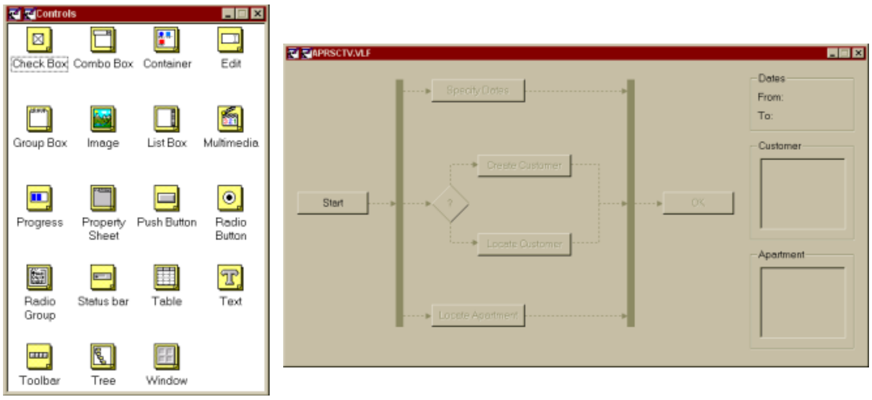

Figure 11. The BOF Lite layout editor. The left window holds the assortment of widgets available to the designer, who by drag-and-drop manipulations lays out the form (the right window). The properties of each widget in the form may be got at by double clicking, whereupon a dialogue box will appear through which these properties may be inspected and modified.

In his writings*,* Oliver Sims does not provide a detailed exposition of the *Newi* system and its implementation, but rather expounds the *ideas* behind the *Newi* system in a generalised manner. The following account will draw heavily on these sources as well as on the *SSA BODTF* submissions and to a lesser extent on the *Newi* documentation and will attempt to epitomise and evaluate the most important ideas presented in these documents.

1.4.2 USABILITY AND THE OBJECT-BASED USER INTERFACE

It appears that the usability of a system is largely dependent on how well the user interface of the system mirrors the user's conception of the real-world objects modelled by the system. A system of which a user may easily create a mental picture will generally be more usable than a system where this is not the case.[675] The corollary of this assumption will be that an *object-based user interface (OBUI),* where the user interface objects map well to the real-world objects understood by end-users, is preferable to a traditional application-centric organisation of the interface.[676]

Arguably, the trend in the business world towards *user empowerment* reinforces the need for usable systems.[677] 'Empowered' users will no longer work with only a single task and a single application of which they know every nook and corner, but will shift between a wide range of tasks and software support systems. The latter must be easy to use, adhere to common *GUI* guidelines, and interact with the user uniformly and consistently.

Sims' books – as well as the *Newi* system – constitute a major onslaught on the conventional shape of a programme, the *application,* and a plea for individually executable *business objects* as *the* succedaneum of the labyrinthine monolith behemoths of yore. Most such business objects will have their own screen impersonations, and whenever a certain object is needed, the very same business object should be used. In this way, the user will not get confused by different representations of the same thing, and the need for replication of functionality in multiple applications is effectively done away with. Typical business objects represent well-known busi-

[675] [Sims94] p. 8 et seq. discusses a 'usability iceberg' model, based on a research project at *Xerox PARC.* According to this model, the mapping between a system and a user's model of the world accounts for around 60% of the usability of the system. Cf. also [ES98] p. 62 et seqq. and [Sims95a] and [Sims96g].

[676] In [ES98], the term *Business Object User Interface (BOUI)* is preferred to *OBUI,* and the *Business Object User Interface* is contrasted to the *Application-Oriented User Interface (AOUI).* A detailed account of the *BOUI* is given in id. op. p. 289 et seqq. For a comprehensive treatment of object-oriented user interface, see [Coll95].

[677] [HKL95] can be characterised as a philosophically grounded manifesto for this trend (see, for example, p. 237). Cf. also [Malo99].

ness concepts like *customer, product, order,* etc. Users should be able to manipulate business objects on the screen directly, e.g. through *drag-and-drop* actions on the icons that represent the objects.

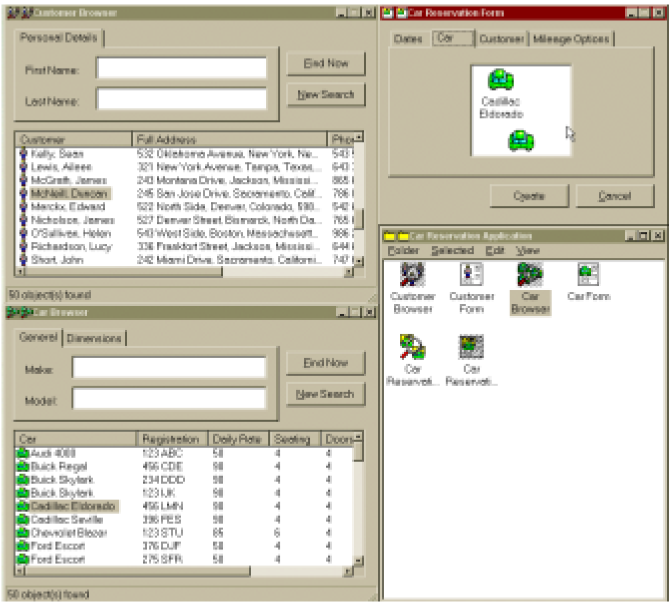

Figure 12. The BOUI (Business Object User Interface) of BOF Lite. A car business object is currently dragged from the car browser (lower left window) into the car reservation form (upper right window). The upper left window is a customer browser business object and the lower right window is a folder containing all the business objects needed for the car reservation task. Note the "mini-icons" located on the title-bars, being stand-ins for the regular folder icons and facilitating drag-and-drop actions with business objects in "window mode".[678] The business objects in the above screen-shot are from the CD-ROM coming with [ES98].

A sticky problem in an OBUI is how *business processes,* i.e. the procedures to be followed for a certain action, such as an order entry or a query for the status of a part, are to be integrated with the independent business objects. One approach would be to have an on-screen 'procedures manual', which shows the necessary steps to be taken, and to tick checkboxes in this on-screen manual automatically as the work proceeds. Better, according to Sims, is, however, to embed the business logic within 'intelligent forms', guiding the user through the completion of themselves in the correct sequence, checking for errors and insisting on valid and complete input. The 'intelligent form' should, of course, be supplemented with context-sensitive help.[679]

Sims also examines what he calls *the workbench problem*[680]*,* which is a kind of atavism of the application-centric mind-set. When a 'workbench', consisting of all items needed for a certain business process, such as order entry or contracting, is designed in isolation from other problem areas, an *iconic application* may result. Such designs, which lack a true object-based user interface and essentially remain applications in the sense of *islands of functions,* will cause a number of serious problems:

678 Such mini-icons called *proxy icons* were also used in the windows of *Taligent's CommonPoint.* See [CP95] p. 103.

679 See [Sims94] p. 17 et seqq. 'Intelligent forms' seem closely related to the *wizards* popular with programme designers today. A neat 'intelligent form' design based on the *UML activity diagram* is suggested in [ES98] p. 122 et seqq. – for an example, see *Figure 11.*

680 [Sims94] p. 21 et seqq.

- cross-application duplication of functionality
- difficulties of application integration
- several versions of an object representing one and the same business concept

In a truly object-based environment, the objects are re-usable across business processes, and it should be possible for an ordinary user to control and take advantage of such re-use. Users should also be allowed to group business objects in *container objects* or *folders* according to their own needs and whims.[681]

Current *GUI* software has almost universally succumbed to the temptations of the workbench approach and thus sticks to the traditional monolith application *shape*.[682] In short, the prevailing object-oriented approach lets object-orientation end at compile-time. The objects laboriously identified during object-oriented requirements capture, analysis, and design and no less laboriously implemented with an object-oriented language during the construction phase all of a sudden disappears into thin air during compilation and linking, being sucked into a monolith salmagundi devoid of the slightest trace of them. To the end-user, no objects will be discernible, nor will they be available to users and business developers for re-use, modification, or plug and play. The end-product of all this massive application of the object-oriented armature will in effect be an indissoluble amalgam of the allegedly so beneficial object-oriented building blocks – a "traditional application".[683]

The *Newi* interface was based on the *CUA-91 (Common User Access-91)* user interface guidelines and leaned heavily on the now somewhat dated *MDI (Multiple Document Interface) GUI* style, distinguished by having multiple *client windows* within a *frame window*.[684] The document-centric approach, implying a tighter integration of screen objects, became popular, mainly through *Microsoft's OLE,* after the gestation of *Newi* and had little influence on it.[685]

1.4.3 *COOPERATIVE BUSINESS OBJECTS* AND THE PROBLEM OF INTEROPERABILITY

To make the business object vision come to life and to get rid of any "artificial 'application' barriers"[686], a mechanism must be devised that makes independently designed and developed, loosely coupled business objects interoperate and – what is more – co-operate. This by no means simple task is referred to as the *integration problem* by Oliver Sims.[687]

The solution to the integration problem suggested by Sims and attempted in the *Newi* system is a new kind of software shape, the *Cooperative Business Object (CBO)*.[688] It has been so named, because

- it is a *bona fide object* in the object-oriented sense, supporting encapsulation, polymorphism, and inheritance[689]

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681 [Sims94] p. 24 et seqq.

682 [ES98] p. 51 et seqq. repeats the above criticisms against the "traditional application": On p. 58 the complaints are listed thus: Traditional applications "are islands", "are difficult to maintain", "don't integrate", "are monoliths", "impose artificial boundaries", "are an artificial deliverable", "are function oriented", "duplicate concepts", and "are resistant to change". The corresponding bounties of "business component-based applications" are listed on p. 97: These "reuse components", "are highly maintainable", "are easy to integrate", "are not monoliths", "impose no artificial boundaries", "are composed of real-world concepts", "are object oriented", "have a single representation of a single concept", and "embrace change".

683 [ES98] p. 59 et seqq.

684 The *Business Object User Interface* of [ES98] p. 289 et seqq. provides a minor modernisation of this *GUI*. [Sims96g] chides the *Windows 95* user interface for returning to the "old file-based user's model", being "a GUI-ised version of the DOS file model", but admits that also the *OS/2 GUI* is a compromise between the object-based *CUA-91* and the traditional file model.

685 [OHE96b] p. 329 mentions plans for support of *OpenDoc*. Cf. also [SSA97b] p. 12 and [ES98] p. 287.

686 [Sims94] p. 27.

687 Ibid.

688 [Sims94] p. 277 et seqq. gives a "technical" account of the *CBO* concept. [SSA97a-c] uses the term *XO (eXecutable Object)* instead of *CBO*. The terminological reform attempted in [ES98] is explained below on p. 148.

689 [Sims94] p. 280 et seq. and [OHE96b] p. 331 et seq. give some more particulars about the nature of these objects.

- it maps to *business* concepts, such as e.g. customers, invoices, and orders[690]
- it *co-operates* with other *CBOs* in order to perform various tasks

Taking a more traditional primrose path, one might dodge the integration issue either by designing a large monolith application that encompasses all functionality needed for a certain business process, or by manufacturing a number of small applications that interoperate through complicated custom communication protocols. These ways of doing things will, however, not overcome the 'workbench problem' mentioned above. For such a feat to be accomplished, a fundamental shift is needed in the way software is built, a shift away from manufacturing applications to building reusable *CBOs.*

In summary, the overall objective of the *CBO* approach, according to Oliver Sims, is to create a programming model with the characteristics listed below:[691]

- a simple conceptual model for the programmer
- programming language independence
- application integration
- ease of programming
- wide applicability

A *CBO* is a *deliverable,* an *end product,* that executes independently on its own, not being a part of any *application.* Probably, it will also need access to the executable code of a number of superclasses, and, most certainly, it will need the support of a rich infrastructure. Although each *CBO* is an independent executable, many *CBOs* may execute within the same process – they may, for example, be implemented as *DLL* files or shared libraries. For performance reasons, this will actually be the rule.

Notwithstanding that a *CBO* exhibits object-oriented behaviour, it may be written in any language, procedural as well as object-oriented – *CBOs* are not *language objects* in object-oriented programming languages.[692] *CBOs* should be easy to programme, not requiring profound system-level expertise of the programmer, although it should be possible to use any system facilities for those who opt for it. Even script languages like *REXX* may be taken advantage of, making it possible for skilful users to write their own business object code.

CBOs should be both *plug-and-play,* providing support for easy installation by end-users, and *interoperable,* being capable of easy interaction with each other.[693] It should be possible to combine *CBOs* from different providers *ad hoc* without the need for programme code changes, re-compilation, and re-linking. This may be achieved by using messaging as an interoperability mechanism, which, as will be explained below, offers the late binding and loose coupling capabilities needed for *ad hoc* integration.

CBOs may be distributed freely and transparently across a network. Whether a *CBO* referenced is local or remote, must not be a concern of the *CBO* programmer who wants to access it.[694] Additionally, *CBOs* will usually be transparently persistent over power-down, although transient *CBOs* may sometimes make sense as well. Initialisation, memory allocation, and garbage collection will be handled by the *CBO* enabling infrastructure – as well as a plethora of other tasks.

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[690] [SSA97b] p. 10 suggests the use of a "business object language" for the specification of *business objects.* In [ES98] p. 232 et seqq., such languages are referred to as "component specification languages". Traditionally, an important motivation for such formal specifications has been the prospects of automatic code generation.

[691] [Sims94] p. 43.

[692] [SSA97b] uses the term *technology object* to denote objects that are not *XOs* such as language objects or *CORBA ORB* objects, whereas [ES98] instead uses the term *embedded object.*

[693] [Sims96a] p. 37 et seq., [Sims96f] p. 17 et seq., and [ES98] p. 133 et seqq. and p. 254 et seqq. Id. op. p. 141 et seqq. and [SSAO96a] p. 5-21 et seqq. give a nice example of the ad hoc interoperability made possible with *business objects,* viz. a *telephone* object that will ask any business object that is dropped onto it for its "telephone number" and "name". The *telephone* object and the object dropped on it, for instance a *customer* or *resort* object, only need to agree on the semantic tags "telephone number" and "name" to be able to interoperate!

[694] [ES98] p. 81 discusses a *business component repository,* where the *business components* available at a site are stored.

A *CBO* class may inherit from another *CBO* class, forwarding any messages that it cannot handle by itself to its parent class. Such inheritance equals single implementation inheritance; interface inheritance is not relevant for *CBOs,* since they do not expose any traditional method/data interfaces at all, but are accessed through semantically tagged messages.[695] *Newi* and the *CBO* programming model put forward in Sims' books do not support multiple inheritance, a feature that complicates method look-up considerably and makes it necessary to handle diamond-shaped inheritance graphs, message name clashes, etc. Data are not inherited, but only methods, although parent data may, of course, be set and got through the appropriate messages. Attribute names must be unique within a class, but may be duplicated in superclasses. A class is an object in its own right, providing, for example, class factory functionality, and both class and instance methods/data are available. It is possible to forward a message to the immediate superclass ("super"), and messages may also be sent to the current object ("self").

Method dispatch is done in a dispatch loop internally in the *CBO,* and thus languages that do not support multiple entry points (such as *IBM's* script language *REXX)* are allowed for. Method dispatch is done at message time, and thus binding is late and all methods may be considered virtual. A message that is not handled by the current class should be forwarded to the superclass, and, at times, this will be reasonable also for messages that are handled in order to bring about method combination with homonymous superclass methods. Such method combination will, for instance, be regularly done to handle the *Set* and *Query* messages in order that all relevant attributes will be covered by the operation. Class hierarchies are defined through configuration files and may be re-factored dynamically. More details about messaging and method dispatch will be given below.

1.4.4 AN ATTEMPT AT A TERMINOLOGICAL CLARIFICATION

In *Building Business Objects,* Peter Eeles and Oliver Sims attempt to disambiguate the skein of meanings the term *business object* has come to take on and to reduce the heavy terminological overload of this phrase by means of a kind of nomenclature reform.[696]

The *OMG* definition of a *business object* as "a thing active in the business domain" is taken as the starting point of this terminological clarification, for the purpose of which the term *business object* is tracked through a number of development phases: *requirements capture, analysis, design, construction,* and *run-time.* During *requirements capture* a primordial *business concept* is discovered, which commonly is referred to as a *business object* as well, and in all the subsequent stages the term *business object* is used to represent this concept: During analysis the *business object* is a *type,* which is transformed into a *class* during design. This design class is then implemented by a *language class,* the run-time representation of which is an *object.* All these representations (type, class, language class, and object) are referred to as a *business object.*

Additionally, during the different phases various classes and objects crop up besides the *business object* that represents the *business concept.* These include

- subsidiary *business types*
- *framework classes,* which add useful functionality to the business object by implementation inheritance
- *utility classes* like, for example, "money"
- *technical classes* for thread handling, memory management and the like

These different helper classes accumulate during all the different development phases: During analysis, subsidiary *business types* are added, during design some *framework* and *utility* classes probably need to be put in, whereas *technical classes* are appended in the construction phase. At run-time, all these classes will be in-

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695 In theory, sets of messages could, of course, be organised into message interfaces, which, in turn, could be arranged hierarchically. This is, however, not done for *CBO* messages, although [SSA97b] p. 25 uses the concept *semantic interface* to signify the set of operations and semantic tags understood by an *XO.* Such semantic meta-data may be stored in semantic interface repositories, which might be useful when trying to achieve plug-and-play interoperability between unrelated *XOs.*

696 [ES98] p. 5 et seqq. Cf. also [HS98a] and [HS00], where this reform is further elaborated.

stantiated into a gallimaufry of objects mixing and blending with the business objects proper. In short, the proliferation of classes and objects threaten to seriously obfuscate the unity of the business object.

In order to avoid such occultation, all the above classes are collected into a *distributable component (DC),* a module-like construct, which is used during analysis, design, and construction. At run-time, the *distributable component* is instantiated into a *distributable object (DO),* which – in contrast to the business, framework, utility, and technical objects being part of it – is network-visible. Additionally, a class implemented by a *DC* is called a *distributable component class (DC class)* and the (DLL) file in which it is delivered a *distributable component module (DC module).* Classes that are used internally in a *DC,* but are not visible outside it are called *embedded classes* and their instances are called *embedded objects.*[697] Eeles and Sims characterise *distributable components* and *distributable objects* as "the technical vehicle for realizing business objects".[698] For *DCs* and *DOs* to become useful, an infrastructure, or *Business Object Facility (BOF),* is needed as well. The *BOF* defines a "socket" into which *DCs* will be "plugged" at deployment time and *DOs* at run-time.[699]

In a typical distributed client/server environment there will be *DCs* and *DOs* that represent the same *business concept* both on clients and on servers.[700] Four distribution tiers, the *user, workspace, enterprise,* and *resource tier,* are discerned (these will be described below). There are *DCs* and *DOs* belonging to each of the four tiers, revealing their respective abode through designations such as *user interface distributable component/object (UDC/UDO), workspace distributable component/object (WDC/WDO), enterprise distributable component/object (EDC/EDO),* or *resource distributable component/object (RDC/RDO).* To avoid conceptual fragmentation, the term *business component* is used as an all-encompassing abstraction for all the different *DCs* that represent a particular *business concept* as well as their corresponding *DOs.*[701] Although a *business component* corresponds to a single *business concept,* it may contain any number of *DC classes* or *objects.*[702]

There are three distinct functional categories of *business components: process, entity,* and *utility business components. Process business components* represent processes such as *order placement,* whereas *entity business components* correspond to entities such as *customer* or *order,* and *utility business components* to useful tools such as *calendar* or *address book.*

In Herzum's and Sims' recent book, the above terminology is modified, simplified, and supplemented in a number of ways:[703]

- the epithet *distributed* is substituted for the somewhat awkward neologism *distributable*
- the run-time instantiation of a *distributed component* is no longer called a *distributed object,* but is either referred to as a *distributed component* or, for clarity, as a *distributed component instance*[704] – perhaps it was felt that the earlier distinction between *component* and *object* did not conform with any common usage
- the business object infrastructure, which previously was known as a *business object facility,* is now called a *component execution environment (CEE)*[705] and made part of the wider notion of a *business component virtual machine (BCVM),* which encompasses "the set of development tools

697 The characteristics of distributable and embedded objects are contrasted in [ES98] p. 173.

698 [ES98] p. 8.

699 Cf. [HS00] p. 139 et seq.

700 If a multi-tier architecture is opted for, there may be even more representations around.

701 [ES98] p. 179 et seqq. The term *business component* is applied somewhat inconsistently not only to the *components* of analysis, design, and construction, but also to the corresponding run-time *objects* – to overload the phrase *business object* yet another time in order to enforce consistency in the usage of the terms *component* and *object* would indeed defeat the authors' purpose of terminological demystification!

702 Ibid. it is suggested that a *business component* may be well represented by a *UML package.*

703 [HS00] p. 35 et seqq. Some of these modifications were adopted already in [HS98].

704 See [HS00] p. 88.

705 [HS00] p. 556 defines it as "the run-time technical infrastructure, services, and facilities required to provide the appropriate separation layer for distributed components and to enable business components to collaborate"

and run-time deliverables that enable business components to be built and run independently of underlying plumbing and software technology considerations".[706]

- a set of *business components* that co-operate in order to provide the "functionality required by a specific business need" is referred to as a (white-box) *business component system* and can be (black-box) encapsulated in a very coarse-grained *system-level component (SLC),* which, in turn, may interoperate with other *SLCs* in a *federation of system-level components*[707]
- to the three functional categories *process, entity,* and *utility business components* is added a fourth, the *auxiliary* one, which is used for concepts that are not found during analysis, but are needed by the run-time system, i.e. technical components such as a database integrity monitor, a performance monitor, and the like[708]

Although the current terminological bewilderment may tend to obscure the discourse on *business objects* somewhat and clarification will be laudable *per se,* objections might be raised against the route taken above. The massively overloaded term *component* is hardly a better choice than *object* and its use appears largely to be a concession to its present popularity.[709] Furthermore, the epithets *distributable* and *distributed* do not seem to catch the essence of the concept to be characterised very well. Somewhat peculiarly, the *SSA BODTF* proposal employed yet another argot and, more aptly, renamed *CBOs eXecutable Objects (XOs)* and made no use of the term *component* at all.[710] In our view, the term *object* should be preferred for entities that support important object-oriented properties (implementation inheritance, polymorphism, etc.), such as Sims' original *CBOs,* whereas *component* should be reserved for entities that adhere to a commercial component technology, such as *COM/ActiveX* or *JavaBeans*. However, this is perhaps just a matter of taste.

1.4.5 USER LOGIC, DATA ACCESS LOGIC, AND BUSINESS LOGIC

In client/server systems three different kinds of "logic" are conventionally discerned, viz. *user, data access,* and *business logic*. Sims argues that *user logic,* handling the *GUI,* and *data access logic,* handling the access of shared data, should be kept in separate threads or processes – which in the latter case may execute on different machines – and that the connection between these should be *asynchronous*.[711] The rationale for these requirements lies in the difference in response times. Whereas user logic always should respond promptly (within a fraction of a second), data access logic will typically require response times that are one or more orders of magnitude greater.[712]

The third kind of logic, *business logic,* is used to enforce *business rules*. Business logic is not concerned with the validation of input fields – that is the task of user logic – or with the access of single database tables – this

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[706] See [HS00] p. 556 and p. 287 et seqq. Don Kavanagh is credited with the coinage of the term *business component virtual machine* (see id. op. p. 329).

[707] Thus, there are five levels of component granularity: *language class, distributed component, business component, business component-system* (or, if encapsulated, *system-level component),* and *federation of system-level components*. See [HS00] pp. 59. Cf. also id. op. p. 38 for a distinction between *continuous* and *discrete recursion*. If *continuous recursion* is applied there are no distinct granularity levels, but components may contain other components recursively to any depth. In contrast, *discrete recursion* implies the definition of distinct component granularity levels, such as those mentioned.

[708] [HS00] p. 180 et seq.

[709] It may be noted that [ES98] p. 286 predict that business object technology will coalesce with *GUI*-oriented component technologies such as *ActiveX* and *JavaBeans* within a few years. The component term and idea made a strong impact also on the *BODTF* effort, as witnessed by designations such as *Business Object Component Architecture*.

As another nod towards popular terms and notions, [ES98] p. 84 et seqq. et passim even start using the term *application* for a folder with some interoperable *business objects* inside, although what is popularly understood by *application* still is anathema in their view. The "traditional application" is, for instance, thoroughly criticised on p. 51 et seqq.

[710] [SSA97a-c]

[711] [Sims94] p. 45 et seqq. See also [HS00] p. 299.

[712] The requirement for asynchronous connections is often moot, insofar as it might complicate the *GUI* logic unnecessarily. Determining which actions are permissible when users are waiting for data is mostly a very difficult task. If users are given free reins, they may, for example, close the window/form/dialogue box in which the data being retrieved were supposed to be presented, rendering the entire retrieval operation useless.

falls within the realms of data access logic. Rather, business logic is responsible for the overall integrity of the data handled in a process, ensuring, for example, that *all* tables in a relational database that should will be updated properly. Clearly, business logic is closely allied with commit and rollback handling, and in most cases, it should co-reside with the data access logic.[713]

The user logic is said to belong to the *User Interface Domain (UID),* whereas the business/data logic is part of the *Shared Resource Domain (SRD).*[714] The *SRD* part of the software may execute on the client *PC,* on the database server or on a separate machine or on any combination of these. Until quite recently, the *UID* software would usually execute only on the client *PC.*[715] The introduction of thin clients, however, may imply that part of the *UID* is moved to the server.[716]

In the Eeles/Sims book, a *Workflow Domain (WFD)* has been interposed between the *UID* and the *SRD,* although this domain seems to have disappeared again in the recent Herzum/Sims book.[717] The *Workflow Domain* is said to be "responsible for the execution of workflow-style business processes of various kinds, including mobile agents, workflows, activities, and transaction coordination". *WFD DOs* may move between machines and, thus, may be conceived of in terms of static or mobile agents.

Furthermore, Eeles and Sims improve the original *UID/SRD* model by subdividing the *UID* and *SRD* into two layers each, thereby creating a four-layered client/server model.[718] The *UID* layers are the *User Interface Layer* and the *Workspace Layer,* whereas the *SRD* layers are labelled the *Enterprise Layer* and the *Resource Layer.*[719] The *User Interface Layer* is, of course, concerned with the user interface, whereas the *Workspace Layer* accommodates the local representations of the business objects *cum* their data and associated behaviour. The *Enterprise Layer* is the *SRD* counterpart of the *Workspace Layer* and holds the shared business objects. The *Resource Layer* separates the enterprise business objects from their database representations. The four layers correspond to four distinct types of *DCs/DOs:* The *User Interface DC/DO (UDC/UDO),* the *Workspace DC/DO (WDC/WDO),* the *Enterprise DC/DO (EDC/EDO),* and the *Resource DC/DO (RDC/RDO).*[720] The various responsibilities of these will be examined in due course below.

1.4.6 ACHIEVING LOOSE COUPLING THROUGH MESSAGING AND *SEMANTIC DATA STREAMS*

To be able to overcome the aforementioned *integration problem, CBOs* cannot interoperate through early-binding mechanisms like the method invocations of object-oriented programming languages.[721] Furthermore,

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713 The *presentation, data,* and *application [logic]* of [Sims96g] p. 22 and [ES98] p. 184 correspond closely to the *user logic, data access logic,* and *business logic* of [Sims94]. [RSEM+97] discuss the handling of business rules for a *JavaBeans*-based architecture apparently inspired by Sims' ideas. Cf. also [RDRE+00].

714 [Sims97] uses the terms *Presentation Logic Domain (PLD)* and *Shared-Service Domain (SSD)* instead, whereas [HS00] talks about the *user workspace domain (UWD)* and the *enterprise resource domain (ERD).* [HS00] p. 127 introduces the term *distribution domain* to signify such "logical domains or areas of responsibility". There may be more than one *SRD* in a system, since the scope of each *SRD* is defined by the transaction scope, as explained in [ES98] p. 194 et seq. A system with two transaction monitors that do not interoperate will, for instance, have two *SRDs.*

715 For a discussion of two- and three-tier client/server architectures, cf. also [Pers96] p. 8.

716 [ES98] p. 193.

717 [ES98] p. 190 et seqq. From the very curt description given here, it may be concluded that the ideas about the *WFD* were somewhat embryonic. Similarly, [SRHL98] advocate a "5-layer architecture for business objects frameworks", which comprises a presentation, business process, business entity, data access, and data storage layer. Cf. also [Schm99a].

718 [ES98] p. 169 et seq. This model is retained in [HS00] with only minor modifications.

719 In [HS00] p. 118 et seqq., these are called *distribution tiers* and their names are slightly modified into the *user tier, workspace tier, enterprise tier,* and *resource tier.* Additionally, the occasional need for further tiers, such as a *testing tier* or a *gateway tier,* is also considered.

720 As already pointed out, the distinction between components and objects is gone in [HS00]. The four categories of *DCs* are here given as *User DC (UDC), Workspace DC (WDC), Enterprise DC (EDC),* and *Resource DC (RDC).* In addition, the usefulness of special-purpose *Gateway DCs (GDCs)* and *Testing DCs (TDCs)* is suggested.

721 [Sims94] p. 142 et seq. presents a number of objections to the strongly typed, early-bound *IDL* interfaces typical of *CORBA* and – to a lesser extent – *COM/OLE.* Such structured interfaces create tight couplings between objects and give rise to all kinds of fragility problems, showing up in the avalanches of adaptations, re-compilations, and re-links that tend to snowball upon even minor interface

it will be desirable to reduce the surface area of the interfaces of the *CBOs* to the smallest possible in order to abate inter-*CBO* coupling and dependencies.[722] In addition, the requirement for asynchronous interconnections must be fulfilled. Small surface area, asynchronous IPC, and the late, dynamic binding needed[723] are achieved through the reliance on *messaging*[724] for inter-*CBO* communication together with parameter passing through *Semantic Data Streams (SDS)*.[725]

An inter-*CBO* message will need to contain: [726]

- a message name
- data in *SDS* form
- a *reply space* for the receiver
- the sender's object identifier
- an identifier for the sending user

The *reply space* enables the receiver of a message to return data in a uniform way to a requester, irrespective of whether the call is synchronous or asynchronous. In the latter case the infrastructure will create and post a reply message that contains the data deposited at the reply space. Thus, the requester must have specified the name of the reply message as well. The last two items are handled by the infrastructure and are seen neither by the sender nor by the receiver. The sender's object ID is needed as the address of the reply message, and the user ID may be necessary for authorisation purposes and the like.

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changes. [Sims96a] p. 39 et seqq. denounces *IDL* as a "kind of distributed linkage editor" that ineptly forges components together into a very fragile compages. He succinctly sums up his view on *IDL* interfaces thus: "business objects should not be glued or welded together; they should be clipped or blue-tacked together." Cf. also [Sims96b] and [HS00] p. 220 et seqq. The paragraph on *component specification languages* in [ES98] p. 232 et seqq. seems to imply a major gyration on this issue, perhaps to be understood as an attempt to sail with the then current *OMG* and *BODTF* wind rather than against it. Cf. also [HS00] p. 326. For a discussion of the fragility issues that spring from the reliance on implementation inheritance in object-oriented programming, see below p 234 et seqq.

Just like *COM,* Sims' approach (implemented in *Newi)* is *binary* in nature. [SSA97b] p. 3 and 39 contends that a binary standard is necessary for interoperability and ad hoc integration of business objects from different providers. [SSA97b] p. 12 states that a binary standard would have to encompass "entry point names, binary module types for different platforms, precise calling mechanisms for XO-to-BOF binding, etc.". Cf. also [ER97a] and [ES98] p. 148 et seqq.

[722] The meaning of *surface area* is set down by [CN91] p. 17 as "the number of things that must be understood and properly dealt with for one programmer's code to function correctly in combination with another's". [Digr95] p. 152 et seq., summarising a list given in [CN91] loc. cit., frames some "factors influencing surface area":

- "amount of visible information", i.e. the named items of an interface including attribute and operation names and data types
- "sequence dependencies", i.e. restrictions on the order in which operations are to be performed
- "environment and responsibility scope dependencies", e.g. handling of lifecycle, persistence, and location aspects
- "technology dependencies" on techniques and interfaces for handling miscellaneous infrastructure aspects such as communication, middleware, data storage, etc.
- "concurrency", i.e. concurrency issues exposed to the user

[723] The type of very late binding discussed here is sometimes referred to as *message-time binding*. Cf. [OHE96b] p. 329 et seqq.

[724] The idea of combining messaging with objects is at least as old as the *Smalltalk* programming language. Although current *Smalltalk* variants only support a synchronous messaging model that is roughly equivalent to the method calls of mainstream object-oriented languages, at some stages in the development of the *Smalltalk* language also asynchronous messaging between process-like entities called "activities" seems to have been considered by the *Smalltalk* designers, as indicated by [Kay77] p. 238 et seqq. In any case, *Smalltalk* messaging is reminiscent of *CBO* messaging in that restrictions on what types of messages may be sent to an object are absent – if the object does not support a certain message, a dialogue box will report "Message not understood" to the user.

[725] [Sims94] p. 140 et seqq. In [OHE96b], [SSA97a-c], and [ES98], the term *Semantic Data Object (SDO)* is used instead of *Semantic Data Stream*. Additionally, [ES98] names messaging with self-defining messages *semantic messaging* and uses the term *Semantic Data Facility* for the agency providing support for it in *BOF Lite*. [HS00] (see p. 220 et seqq.) instead talk about *tagged data* and apparently regard it as a special-purpose technique rather than as the basis of the *business component* technology advocated in this work.

[726] [Sims94] p. 128 et seq. In [ES98], such a message is called a *semantic message* and the self-defining data held by it are called *semantic data*. The *SSA BODTF* submissions [SSA97a-c] name such a message a *BofRequest*. Cf. also [HS00] p. 299 et seq.

A *Semantic Data Stream* is, simply put, a collection of parameter values tagged with semantic meta-data as well as type information, which will allow automatic type conversions to be made.[727] A typical *SDS* may appear like this[728]:

```
[Name] <Samuel Johnson> (Str) [Profession] <lexicographer> (Str) [Age] <288> (int)
```

From the point of vantage of the programmer, an *SDS* may be regarded as a black box or a blob. By calling an *API* function, the programmer may extract any item by name without having to care about type conversions, which will be handled automatically by the *API* function.[729] Messaging with *Semantic Data Streams* lets go of the strongly typed, positional interface structures of traditional *APIs* and shifts the focus over to the semantic labels. These labels must be agreed upon between *CBOs* to make co-operation possible.[730] Preferably, the vocabularies of different areas should be standardised, so that independent *CBO* programmers will be able to speak the same language in their message *APIs.*[731]

The use of messages and semantic data streams reduces coupling[732] and surface area[733] appreciably and promotes resilience to change.[734] A *CBO* programmer may change the type, position, and size of an argument – at least within certain bounds – without having to modify all potential recipients of a message. Consequently, the problems caused by the introduction of new versions of *CBOs* are considerably assuaged. If, for instance, a new version of a sender *CBO* adds an item to an *SDS,* no changes need to be made to the receiver *CBOs,* although only a new version of a receiver *CBO* may take advantage of the particular data item added. All previous versions of receiver *CBOs* will still work, as long as no data item needed by the receiver is removed from the *SDS*.

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[727] [Moon97] p. 46 et seq. mentions an interesting application of *semantic data streams* to capture class meta-information and object data at run-time. The semantic data stream is then used by a persistence layer to map the object to a particular database representation.

[728] In [SSA97b] (see p. 76 and 112 et seq.) a somewhat different notation is used, supporting also nested data structures:

```
{
    [Person,String] "Samuel Johnson"
    [Profession] "lexicographer"
    [Age,Long] "288"
    [British,Bool] "True"
    [Address]
    {
        [Street, String] "Grub Street"
        [City, String] "London"
    }
}
```

Label, type, and value are all optional. [SSA97b] p. 76 et seqq. also states that *XOs* generally support the *Query* and *Set* messages. The attributes that are queried or set are given by the contents of the *SDO*. All attributes of an *XO* should be retrieved, if a *Query* message is issued with no arguments. The above notation is also used in *Newi,* where it is used not only for messaging, but also as the format used for configuration files, which play a very important part in the *Newi* system.

[729] The *CBO* infrastructure may also support user-defined types and conversions – cf. [Sims94] p. 143. If *CBOs* are sending messages across machine boundaries, it might also be necessary to do conversions between different character sets (see [Sims94] p. 144 et seqq.). Type conversions will impair performance, so the *CBO* programmer should try to match types, when performance is important ([Sims94] p. 143).

[730] [SSA97b] p. 26 summarises: "XOs are tightly bound semantically, rather than being tightly-bound technically."

[731] [Bake97a] points out the similarities between *CBOs* and *agents* and particularly between inter-*CBO* messaging and inter-agent communication. *CBOs* may be viewed as a special type of object-oriented, reactive agents, impersonating domain concepts and consequently having a more clearly defined *shape* than most agents. By the same token, agents may be seen as a special case of business objects. [Bake97a] also pinpoints the parallel between *Sims'* semantic messages and *XML (eXtensible Markup Language),* which supports the tagging of data in a manner quite similar to that utilised in an *SDS*. The current specifications of *XML* and various related technologies as well as a wealth of other *XML*-related materials are available on the *W3C XML* web page http://www.w3.org/XML. A bird's-eye view of *XML* will follow below on p. 562 et seqq. – another can be found in [MFDG98] –, whereas [GP02], [Ligh97] and [Brad98] provide a fuller treatment and [Conn97] a pick of interesting essays about *XML*. Cf. also [Carl98], [ES98] p. 286, and [HS00] p. 223 et seqq.

[732] *Coupling* is a measure of the degree of (undesirable) interdependence between software modules and components. The term has been used at least since the heyday of structured design and is usually contrasted to *cohesion,* a measure of the degree of (desirable) association between the elements inside a module or component (see e.g. [SMC74] or [DeMa79] p. 308 et seq.). Cf. also [Sims94] p. 138 et seq. [HCG96] and [Booc94] p. 136 discuss *coupling* and *cohesion* from an object-oriented perspective. Cf. also [Prin96] p. 46 et seqq.

[733] [Sims94] p. 139 defines binding as "both coupling and surface area".

[734] See [ES98] p. 148 et seqq.

Although messaging is basically an asynchronous IPC mechanism, messages may be either asynchronous or synchronous – in the prevalent parlance, the former type of messages is said to be *posted,* whereas the latter is said to be *sent.* When a synchronous message has been dispatched, the sender will block until the receiver returns, and, furthermore, a result value may be directly transferred back to the sender. The *Send* and *Post* operations both need arguments for specifying the target *CBO* object ID (the *TargetCBO* parameter below) and the message sent *('Message'),* and yet another for passing a self-describing package of data in *SDS* format *(DataSDS). Send* and *Post* differ in one parameter only, since *Send* will need an argument *(ReplySDS)* where the retrieved data are passed back, whereas *Post* will need a special argument *('ReplyMsg')* that specifies the return message, if any:

```
rc=Send(TargetCBO,'Message',DataSDS,ReplySDS)
rc=Post(TargetCBO,'Message',DataSDS,'ReplyMsg')
```

To the receiver of a message it will be entirely transparent whether the message has been sent or posted – it simply returns the reply in an *SDS*. It is with the infrastructure the responsibility lies of delivering the reply *SDS* back either in the *ReplySDS* argument of a *Send* operation or through a separate message *('ReplyMsg'),* in case the original request was posted.[735]

Since messages are sent between independent executables, some kind of message-propagating middleware is needed. *Newi* was one such piece of middleware.[736] In addition to handling inter-*CBO* messaging, the infrastructure should convert external events into messages. The middleware should also handle *GUI* and communication *APIs* as well as multitasking and cross-language considerations in order to reduce the complexity of *client/server* programming to a level suitable for ordinary business developers rather than expert system programmers. Simplicity is the overriding goal of the business object infrastructure – the business programmer should not have to be concerned with "tasks such as thread management, concurrency, memory management, deadlock-avoidance strategies, and existence-transparency".[737] More details about the *CBO* infrastructure will follow below.[738]

A *CBO* may be uniquely identified through some kind of *object ID*. Oftentimes, a *CBO* may want to send a message to another *CBO,* the *object ID* of which is unknown. It should be possible to retrieve the *object ID* of a *CBO,* if its class and instance names are known.[739] For example, if a user enters an invoice number 123456, it should be possible to find the *ID* of the object of class "invoice" with the invoice number 123456. An infrastructure facility providing such translation capabilities amounts to a *name service.* The infrastructure must also cater for *location transparency:* Whether a *CBO* is local or remote, should not be a concern of other *CBOs* exchanging messages with it.

1.4.7 PEER-TO-PEER CONVERSATIONS AND RE-ENTRANCY

CBO messaging is a kind of *peer-to-peer* communication, and, thus, it should be possible for *CBOs* to carry on *conversations* with each other.[740] As we shall soon see, this will require support for multithreading. Conversational interactions imply recursive inter-process calls between objects, which is to say that *re-entrancy* must be provided for. If re-entrancy is made the responsibility of the *CBO* programmer, it may become a

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[735] [Sims96a] p. 44 points out that asynchronous messaging, although sometimes indispensable, might lead into "FSM (Finite State Machine) coding complexities" and should be used with great caution. Synchronous messaging, being much easier to handle, is preferable for most ordinary messaging needs. Cf. also [HS00] p. 458 et seqq.

[736] *Message-Oriented Middleware (MOM)* is a related category of client/server middleware intended for general distributed messaging. See [ES98] p. 287, [HS00] p. 226 and p. 300, and [OHE96a] p. 125 et seqq. See also below p. 590 et seqq.

[737] [ES98] p. 246 et seq.

[738] See p. 157.

[739] In *Newi,* each *object reference* corresponded to a readable *object name,* which consisted of an instance number, the class name, and a domain name separated by the "|" character, e.g. "57|Employee|NEWI". See [SSAO96a]. The inclusion of the class name in the *object name* gives rise to some intriguing problems, as explained in footnote 748 on p. 157.

[740] [SSA97b] p. 21 et seq. In stark contrast to the view given above, [HS00] p. 335 et seqq. emphatically warn against "circularities" and espouse the "Directed Acyclic Graph (DAG) Principle", which dictates that all relations between two components be unidirectional. Only in special cases (id. op. p. 359 et seq.) can peer-to-peer designs be brooked, primarily in "the top-most process layer".

major stumbling block as far as ease of programming is concerned.[741] Hence, it is preferable that re-entrancy is supported by the infrastructure in a way that shields the business programmer from re-entrancy considerations altogether. Since method resolution is done internally within a *CBO,* it will be hard for the infrastructure to deal with re-entrancy at the method level, so the point at issue here is *object* re-entrancy.

Requiring every method of a *CBO* to be programmed so as to be re-entrant would lay a heavy burden upon the programmer, who, for instance, would have to vouch for the mutual exclusiveness of all accesses to the global data of the *CBO.* On the other hand, giving up re-entrancy would imply that only one method in a *CBO* would be allowed to execute at any time, and that any calls of the methods of the *CBO* would be blocked as long as a method of the *CBO* is executing. In this case, however, the methods would only need to be *serially re-usable,* rather than *re-entrant,* implying that the programmer may rest assured that no other thread than the current one will be executing within the *CBO,* when the *CBO* has control.

Assuming that a policy of *serial re-usability* has been adopted, let us consider what happens, when a *synchronous* message has been sent from a method *A* in a *CBO* called *Sender* to another *CBO* called *Receiver,* causing the *B* method of the latter to be called. Now, let us assume that another synchronous message is sent from *Receiver* to *Sender,* which implies that an attempt is made to start a conversation. If *Receiver* and *Sender* execute in the same process, the message will be handled like any recursive function call. This is an example of *local messaging,* which is essentially unproblematic, insofar as all processing is going on within the same thread of execution. If, on the other hand, *Receiver* and *Sender* execute in different processes, we have a case of *remote messaging.* In order to enforce the policy of *serial re-usability* in this case, it seems that the infrastructure will have to block the *Sender CBO,* until its synchronous message call has returned. Consequently, any messages to *Sender* will be blocked and queued, until the call has returned, thereby permitting the original invocation of *A* to terminate. This implies that conversations may not take place between *Receiver* and *Sender.* Even worse, it also implies that any attempts to send synchronous messages to *Sender* from *B* – directly or indirectly – will cause deadlocks to occur. Clearly, this is not acceptable.

The problem of such 'deadly embraces' may be resolved by having the infrastructure block recursive calls only when synchronous messaging is *not* taking place. During a synchronous call, another thread should be allowed to execute recursively within the *CBO* – since this thread represents a recursive call, the policy of *serial re-usability* will still be upheld and the *CBO* programmer will not have to be concerned with concurrency issues. Such a policy of *synchronous non-blocking messaging* can be implemented rather easily, since all messaging, synchronous as well as asynchronous, is done through the infrastructure, which consequently may "open" a *CBO* for recursive calls whenever a synchronous call is made and "close" it again when the call returns.[742] This will be the only exception to the rule that incoming inter-process messages to a *CBO* will be queued until the method or function currently executing terminates and returns control to the dispatch loop.

1.4.8 THE MESSAGE LOOP PROGRAMMING MODEL

The requirement for *asynchronous* connections makes *messaging* preferable to other types of interconnection mechanisms such as *RPC* or conversational protocols like *CPI-C.* Messaging is, however, asynchronous only

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[741] Cf. [Sims94] p. 291 et seq., [ES98] p. 248 et seqq., [HS00] p. 298 et seq., and [SSA97b] p. 22 and p. 67. These accounts do not quite agree on all details. [HS00] p. 305 et seqq. discusses the kindred and possibly even more viciously labyrinthine topics of multithreading and re-entrancy in component-based transaction processing environments, such as *Microsoft's MTS.* See also below p. 587 et seqq.

[742] The recursive call must be located in another thread than the one from which the original synchronous call was issued, since this thread is blocked, waiting for the synchronous call to return. It is the responsibility of the infrastructure to create this thread and to terminate it again when it is no longer needed.

There are some potential problems also with this model. Firstly, during the period when the *CBO* is 'open' for recursive messages, non-recursive messages may arrive as well from totally unrelated *CBOs.* If such messages are allowed to be handled immediately, getting their own threads of execution instead of being queued, they will break the rule of *serial re-usability* and re-introduce the complexities of concurrent processing, such as the need for protection of shared resources. Secondly, if an asynchronous message is part of the same 'flurry' (i.e. message chain) as the recursive message, the recursive message, if handled, will likewise potentially break the rule of *serial re-usability.* Thus, the infrastructure must be able to winnow recursive messages from non-recursive ones, perhaps through some kind of 'flurry identifier', and any asynchronous messages within a flurry must be regarded as breaking the chain of recursion, spawning a new flurry with a distinct flurry identifier. In the *SSA BODTF* proposal, the transaction context *current_tx* of the *BofRequest* structure could be employed as a flurry identifier (see p. 169 below).

from the point of view of the code, in which a message is posted[743], whereas the receiver will have to wait synchronously for a message to arrive.[744] Through the use of a reactive message loop programming model and its combination with the shape of the *CBO,* the synchronous wait will be centralised to one point in the *CBO* and will no longer cause the code to block, unless, of course, there really is nothing to do.

It is the task of the infrastructure to handle the message loops, dispatch messages to recipients, activate the appropriate message loop code when a message arrives, and return responses to clients. Between the processing of messages, the infrastructure will maintain control, so there is no need to waste resources on message polling within the *CBOs*. *CBOs* are entirely event-driven and as such parse and handle the messages received in a case statement. If a case switch is missing for the message, it should be passed to the superclass of the current object through the intermediation of the infrastructure.[745] A business object may, of course, send or post messages to other *CBOs* during the handling of a message. A pseudo-code message loop for a procedural language[746] may look like this:

```
WaitMessage(Message, Data, MessageReply)
    StartCase(Message)
        Case 'GetX'
            MessageReply=X
            Return
        Case 'PutX'
            X=GetFromSDS(Data, 'X ')
            DoSomething(X)
            Send('DB','Update',Data)
            Return
    EndCase
    SuperClass(Message, Data, MessageReply)
    Return
End
```

The *MessageReply* argument should be noticed.[747] This parameter is used to return data and a status indicator to the requester. Using this parameter for returning all data, the *CBO* does not have to care whether a message has been sent or posted to it – it is the responsibility of the infrastructure to return data to the requester in the appropriate way. If the message has been sent synchronously, the data will be returned to the

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743 As mentioned above, in addition to *posting* messages asynchronously, it is possible to *send* synchronous messages, in which case the sender will wait for a response just as is done when an ordinary function call has been made.

744 It would be easy to add an asynchronous, non-blocking "peek" operation as well. Such a peek operation would yield control immediately after having had its peek at the message queue, returning either nothing or the first message in the queue, if there indeed is a message. Actually, a *PeekMessage* operation of this kind is part of many messaging schemes, notwithstanding that experience seems to indicate that it is only seldom used.

745 In the system of architectural styles suggested in [SG96] p. 19 et seqq. and further elaborated in [BCK98] p. 93 et seqq., the *CBO* architecture would plausibly be classified as belonging to the *communicating processes* substyle of the *independent component* style.

746 If an object-oriented language is taken advantage of, the dispatcher code may be generated automatically by a tool, which may be part of the infrastructure. In this case, the messages will correspond to user-supplied methods that will be called from the dispatcher automatically when a message of a certain kind arrives. Cf. [SSA97b] p. 16.

[ES98] p. 230 contains a proposal for such a generative mechanism for *C++*. From an interface definition written in a *Component Specification Language, stub* and *skeleton* files will be generated in the same way as *stub* and *skeleton* files are generated from a *CORBA IDL* file. The *stub* header (hpp) file will contain the definition of a *proxy* class, whereas the *stub* code (cpp) file will provide the implementation of this proxy class. Inside a client, a proxy object will act as a stand-in for the real business object, to which the proxy will further all method calls via the usual semantic messaging mechanism. The *skeleton* header file will supply the interface of the business object class and of the *coordinator* class, which provides the dispatcher method for the business object, and the *skeleton* code file will accommodate the implementation of this automatically generated *coordinator* class. The stub header file must be included in all clients that will access the business object represented by the *proxy* and the skeleton header must be included in the file providing the implementation of the business object. The stub should be linked into the executables of the clients, whereas the skeleton is linked with the server business object.

Although this approach removes the need for some tedious code writing and perhaps provides a programming model more in concert with that of the object-oriented programming language used, it really comes down to nothing but emulating a *CORBA*-style *ORB* on top of a semantic messaging mechanism, thereby creating inter-*CBO* dependencies that effectively annihilate the loose coupling advertised as one the main benefits of business objects. Furthermore, a *Component Specification Language* is an *Interface Definition Language (IDL),* i.e. a contrivance that for good reasons has been repeatedly castigated by Sims (see footnote 721 on p. 151).

747 Cf. [Sims94] p. 128 et seqq.

caller directly upon return from the *Send API* function. In case the message has been posted asynchronously, a reply will be posted to the requester instead.

1.4.9 THE FLEXIBLE NATURE OF *CBOS*

Flexibility should be a fundamental hallmark of business objects. In order to effect maximum flexibility, the *CBO* infrastructure should facilitate easy run-time configuration and re-configuration of various important characteristics of the *CBOs,* including also such unusual items as which executable code implements a certain *CBO* class or which superclass a certain *CBO* class inherits from.[748] It should also be possible to connect different view *CBOs* to a model *CBO* by means of configuration.[749] Such configuration can be done by editing textual configuration files or by using some graphical tool.[750]

In principle, it should be possible to write a business object in any language.[751] In which language a *CBO* is written, is totally transparent to other *CBOs* – a *CBO* written in one language may, for instance, inherit a *CBO* written in a different language. The infrastructure should probably expose its *API* as *C* functions to make it accessible from most languages. If a programming language does not provide support for *C* procedure calls, some custom language adaptation will be needed.

Although sometimes *CBOs* will have to execute in separate address spaces, very often they may run within the same process in one or more threads of execution. It is the task of the *CBO* middleware to make this possible, thereby preventing a significant waste of resources.[752]

1.4.10 THE *CBO* INFRASTRUCTURE

Many early object-oriented client/server projects spent much effort on the development of their own middleware.[753] This can be taken as a sign of immaturity and may well be compared to the woes gone through upon the advent of other new technologies like, for instance, the character-based terminals introduced during the late 60s and early 70s.[754] The advent of these terminals caused a new *OLTP (On-Line Transaction Processing)*

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[748] Cf. [Sims94] p. 126 et seq. and [ES98] p. 35 et seq. The separation of the code that implements a class from the name of the class makes it a matter of configuration, what code (i.e. which .EXE or .DLL file) implements a certain class. This feature is used to solve the "weak client problem" (see [SSA97b] p. 15), which is a consequence of the way clients of *CBOs* retrieve object identifiers from an infrastructure name service by specifying the *class name* of the *CBO* and an instance identifier (cf. p. 154). If a client refers to a *CBO* through an object reference retrieved in this manner and the referenced *CBO* is subclassed by a user who wants to extend the *CBO* in some way, all references to the *CBO* in clients utilised by the user would have had to be adjusted so as to take advantage of the new subclass name, were it not for the separation of class name and code, which makes the necessary adjustment a simple matter of re-configuration. As pointed out in [SSA97b] p. 42, it will also be possible to have multiple class names for one *XO* implementation. Cf. also [OHE96b] p. 331 et seq.

[749] The model-view concept will be discussed below on p. 160.

[750] Configuration files supplemented with various graphical tools were used in *Newi* and *BOF Lite.* In *Newi,* there were .NWI, .SPD, .PKG, and .VLF configuration files, each being structured as a semantic data stream. A .NWI file defined the superclass, package, executable file, views, icons, etc. of a *CBO* class, whereas the .SPD file held its interface (operations and attributes) and class interface as well as a list of valid drag and drop sources. A .VLF file contained the definition of a view, and a .PKG file defined a package. It would, of course, have been possible to save configuration information in some kind of database as well.

[751] [SSA97b] p. 13 states that *Newi CBOs* have been built in *C++, Smalltalk, REXX, Object REXX, COBOL, RPG, Python, Java,* and *C.* The immensely popular *GUI*-oriented *RAD* languages – typified by *Visual Basic* – are notably absent from this list. The way these languages distribute events to the event handlers of windows and *GUI* controls without programmer intervention makes it difficult to write the dispatch loops needed by *Newi.* Cf. also [ES98] p. 219 et seq.

[752] [Sims94] p. 147 et seqq. contemplates the issue whether a *CBO* – and a *CBO* infrastructure – should have its own address space or thread or if address spaces and threads should be shared. It is suggested that the best approach might be to have one thread (or address space) per 'flurry', where *flurry* is understood as a sequence of (synchronous) messages initiated by some external event such as a user interaction, a timer, etc. He also argues that a 'lean and mean' infrastructure, not owning the address space in which it is running, is preferable to the 'big and fat' alternative of an infrastructure in charge of multiple address spaces.

[753] Cf. [Clea96] and [Per96].

[754] Cf. [Sims94] p. 115 et seq. [Sims95b] broaches a theory of "viability cycle" with a cycle time of 10-20 years and gives a crisp historical exposé of programming in support of it. A slightly revised version of this lifecycle theory is also put forward in [ES98] p. 269 et seqq.

computing paradigm to be forged, gradually replacing an older one (batch processing), just as the advent of personal computers, and *GUIs* sparked the client/server revolution of the 90s.[755]

As time goes by, the middleware needed will be supplied in the market overt, at first perhaps as separate products developed by leading-edge providers, then as extensions to the operating system, until it is eventually absorbed into the system infrastructure taken for granted by any and all. To make capital out of the new character terminals, the systems of the 70s needed transaction processing and terminal handling middleware – advanced features not supplied in the batch-oriented systems of that time. Today, such middleware is provided as an integral part or as an extension to most mainframe and mini-computer operating systems. Eventually, the proper type of middleware will bridge also the dismal quagmire where client/server-based software development efforts often go astray currently. *Newi* was an early attempt at such a piece of middleware, providing, as it were, a *socket* for business objects to plug into.[756] And just like the *programmer's model* of the pristine batch programme had to give way to the interactive programme and the transaction programme, when terminals became popular, the *GUI* revolution will naturally favour the object-oriented *shape* of the *Co-operative Business Object.*

A typical *CBO* infrastructure will have to handle and support a wealth of tasks, including: [757]

- message handling and routing, including support for conversations, *serial re-usability*, marshalling, etc.
- thread and concurrency management
- network communication and routing
- object loading and initialisation
- object persistence
- various aspects of object management including the handling of class hierarchies
- naming, event, transaction, and relationship handling
- memory management and garbage collection

Most of these tasks have been dealt with earlier and do not need to be discussed here again.

An infrastructure may also include frameworks facilitating a variety of programming tasks like e.g. drag and drop interactions, object loading and unloading, model/view designs, interest registrations and automatic notifications, and high-level, portable *GUI* handling.[758] Framework *CBO* classes are typically taken advantage of by other *CBOs* through subclassing.

The *CBO* infrastructure given in *Figure 13,* which was appropriated from Oliver Sims' first book[759], provides one example of how the *UID* part of a *Business Object Facility (BOF)* may be designed. The *router* of this example implements the *API* used by the *CBO* application programmers. Its most important task is to forward messages from one *CBO* to another, which may be situated on the same or on different physical machines. The router also co-operates with the *drag-and-drop manager* to facilitate drag-and-drop interactions between *CBOs.*

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[755] In his famous memo *Through the Looking Glass* [Walk88b], the *Autodesk* founder John Walker suggests a somewhat similar scheme of five distinct generations of computers: 1) plugboards, dedicated setup 2) punched card batch, RJE (Remote Job Entry) 3) teletype timesharing 4) menu systems 5) graphical controls, windows. By the same token, [Dam97] discerns four generations of user interfaces, viz. 1) the console switches and lights of the batch epoch, 2) the command line (typewriter metaphor) of the timesharing epoch, 3) the *GUI* (desktop metaphor) of the personal computer epoch, and 4) the "post-WIMP" interface yet to come.

[756] [SSA97b] p. 5. Cf. also [HS00] p. 139 et seq.

[757] [Sims94] p. 123 et seq. gives a few other tasks as well. Cf. also [SSA97b] p. 15 and [ES98] p. 257 et seqq. and 266 et seq.

[758] [Sims94] p. 131 et seqq.

[759] [Sims94] p. 118.

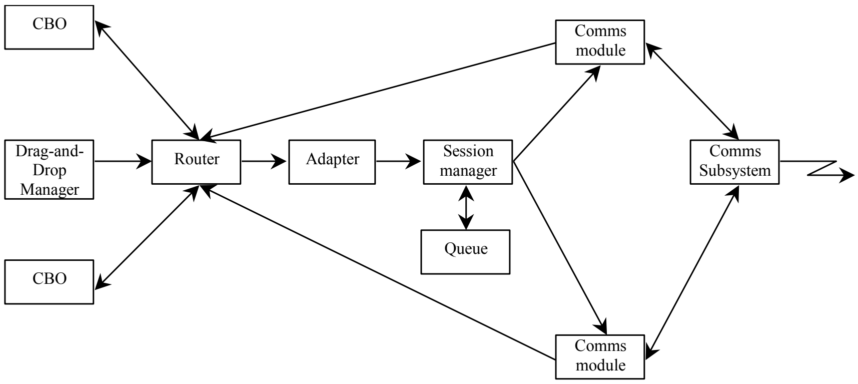

Figure 13. An example of how UID CBO infrastructure may be organised.

The *adapter* shields *CBO* programmers from low-level communication considerations by *adapting* the high-level *CBO* messages to the actual communication mechanisms used. For example, it may map destination names pertaining to remote objects to names used in communication protocols like *TCP/IP*. The *session manager* keeps track of communication sessions and queues messages, if all available communication channels are busy when a message arrives. The session manager may manage a pool of threads or processes communicating with other systems, and it is responsible for communication error handling, logging, retrials, and the like. The *communications subsystem* will encase some operating system communication facility, such as sockets, pipes, or *RPC*. Some communication mechanisms support queuing natively, removing the need for a separate queue handled by the session manager.

Whereas the *UID* infrastructure may be outlined in general terms, because the capabilities of *GUI* client machines will not differ too much, there is much more disparity on the *SRD* side, where we may, for example, find legacy mainframe systems, PC-based LAN servers, minis running UNIX or a proprietary operating system, etc. Server programming may be very different depending on e.g. whether a transaction monitor is used or not or whether such transactional software is component-based or not. The front-end discussed below[760], encapsulating the communication code on the server side, is, however, a component that will be needed on almost all servers.

1.4.11 MEMORY MANAGEMENT AND "GARBAGE COLLECTION"

When objects are executables (.EXE or .DLL files), which is indeed the case with *CBOs*, there will be no unique memory allocated for the instance data of each *CBO* instance, but all instances of a *CBO* class will share global data just like they share the executable code.[761] *Multiplicity mechanisms* should not be the concern of the business programmer, but are better handled by the infrastructure, which, consequently, should provide – preferably transparent – support for handling the instance data of each *CBO* separately.

Furthermore, a *CBO* infrastructure should support persistent objects and the dynamic loading and unloading of persistent *CBOs* to and from primary memory. Inactive *CBOs* occupying primary memory may be written to disk and unloaded, when memory resources are becoming low. Likewise, the data held by persistent *CBOs* should be saved to disk whenever the user is about to close down the system. If a message is sent to a persistent *CBO* that is not active, the infrastructure should activate the *CBO,* and if the *CBO* does not exist, for instance because it has been deleted, the infrastructure should return an error message to the

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[760] See p. 161.

[761] [SSA97b] p. 21. Cf. also [Sims94] p. 285 and [ES98] p. 223 et seqq. Class data should be shared among all instances of a *CBO* class, which is easily achieved by storing it as global data in the executable implementing the *CBO* class. Of course, the purview of such class data will not reach beyond a single machine, although instances of the same *CBO* may indeed be located on more than one computer.

sender.[762] Not all *CBOs* will be persistent, though, and, of course, transient *CBOs* should not be flushed to disk, when they are no longer needed.

In his first book, Oliver Sims used the term "garbage collection" not in the usual sense of cleaning up chunks of primary memory no longer referred to, but to signify the expunction from secondary storage of *CBOs* that were neither needed by other *CBOs,* nor accessible through the folders of the user interface, because the user had removed their icons from all folders.[763] This special type of garbage collection he referred to as *local model ageing*. It must be supplemented by some technique to mark a *CBO* as non-discardable. Additionally, Sims used the concept of *view ageing* to signify a kind of time-out for window positions.[764] When a certain time had expired since the window of a certain *CBO* was last on-screen, its latest position would no longer be saved and the window would not be presented in the same position as it held when it was presented last. Whether this feature has anything to do with garbage collection seems moot. In the Eeles/Sims and Herzum/Sims books, the more conventional notion of doing garbage collection, when there are no longer any references to a *DO* within the *BOF* process, is commended.[765]

1.4.12 *CBOS* FOR THE USER INTERFACE DOMAIN

The *CBO* infrastructure supports a model-view architecture[766] on the client PC.[767] A *model CBO* (or *Workspace DO, WDO)*[768], representing a domain concept like customer, order, or invoice may have zero or more *view CBOs* (or *User Interface DOs, UDOs)* associated with itself and usually also has an iconic representation.[769] Each *view CBO* implements a window presenting the data of the model *CBO* in one way or the other. The view objects are responsible for data display, user interactions and *user logic* like simple validation of fields, whereas the domain of the model object typically includes business logic common to more than one view and the co-ordination of the views, communication with other *CBOs* and the shared resource domain, initialisation, memory handling, user authorisation, and a plethora of other tasks.[770] Model objects often exchange messages, but a view *CBO* should not interact with the views of another *CBO,* but only with its own model *CBO*. Some model *CBOs* do not have a user interface and consequently no view objects. A view *CBO,* on the other hand, may not exist independently, but always belongs to a model *CBO*.

As mentioned above, the model-view separation may be supported by framework classes. In *Newi,* view *CBOs* inherited from the *View* class and model *CBOs* from the *Model* class. There were also various specialised versions of these classes. *PersistentModel* was a subclass of *Model* to be inherited by persistent model *CBOs*. *Container* was a subclass of *PersistentModel* supporting persistent collections. *ContainerView* was a container variant of the *View CBO* class.

The view *CBO* programmer should not have to work with the system *GUI APIs* directly, although he may if he wishes or needs to. The infrastructure may implement a *window manager,* which makes it possible for the programmer to regard the window as an ordinary *CBO* and send messages to it just as to any *CBO*. These messages are converted to *API* calls by the *window manager*. The design of the window is made in a window

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[762] Allowing messages to be sent to non-existing *CBOs* is referred to as *existence transparency* in [SSA97b] p. 22.

[763] [Sims94] p. 136 et seqq.

[764] [Sims94] p. 137 et seq.

[765] See [ES98] p. 258 and [HS00] p. 297. Also [SSA97b] p. 29 and p. 70 uses the notion of *garbage collection* in a more conventional sense and discusses the use of reference counting to determine when deactivation is appropriate.

[766] [BRMS+96] p. 125 et seqq. provides a description of the model-view-controller architectural pattern including various variants.

[767] This architecture has largely been inspired by Jacobson. Cf. [Sims94] p. 297 et seqq.

[768] Besides renaming *CBOs DOs* as discussed above on p. 149, [ES98] introduces new names for all the different categories of *business objects* considered here. Hereinafter, whenever a category is first presented, the new-fangled designation will be given in parentheses after the original [Sims94] name. [HS00] mostly retains these designations, but spurns the term *object* and instead uses *component*. Hence, *Workspace DO (WDO)* has been renamed *Workspace DC (WDC)*.

[769] At times, it may be useful to add an *Icon DO (IDO)* to handle the iconic presentation. See [ES98] p. 199 et seq. [HS00] has abbreviated the term *User Interface DO* into *User DC (UDC)* and also suggests some new kinds of *DCs* of its own, such as *Test DCs (TDCs)* to be used in tests of *business components* and *Gateway DCs (GDCs)* intended for interfacing to external or legacy systems. See id. op. p. 89 et seq.

[770] Cf. [Sims94] p. 80 et seq.

layout editor that creates a layout script file.[771] This file is interpreted at run-time by the *window manager* as it paints the window, thereby providing a very flexible, late-bound association between a layout and its view *CBO*. The window manager also filters and converts the messages coming from the system and then routes them to the view object.

Another kind of *CBO* that dwells in the client domain is the *adapter object*. An adapter object is a system object acting as a proxy for a remote *CBO,* taking care of the transmission of messages across the network. The programmer does not have to care about adapter objects – to him it looks just as if he sent messages straightway to the server objects. An adapter is an example of an *alien object*[772]*,* i.e. a piece of code that acts as an object wrapper around non-*CBO* code, making the alien module look like a *CBO* to other *CBOs*.

At times, another special breed of objects known as *'ghost objects'* will be needed.[773] If, for example, a user is expected to select an item such as a patient or customer from a list of potentially thousands of patients or customers, it will not be feasible to have one *CBO* for each of them, let alone to retrieve data for each from a database on a remote machine. In such cases, *'ghost objects'* may feign real objects, although these ghost objects are sheer appearance and not true objects at all.

Some users will want to modify or customise aspects of the business objects they are working with. Very often, such customisation concerns the user interface, i.e. the view objects, and could be supported through some kind of window layout tool. Since all access of common resources passes through the model objects, the users cannot directly tamper with shared data – if they could, there would be a considerable risk of disastrous mistakes. By subclassing a model object, a user may, however, modify the business logic implemented in an existing model object to his own advantage.

1.4.13 *CBOS* FOR THE SHARED RESOURCE DOMAIN

The most common type of a shared resource is a database to which multiple users have concurrent access. The purpose of a *resource manager* is to ensure the integrity of a shared resource. A *database management system (DBMS)* or a *transaction processing monitor (TPM)* are both examples of resource managers. The unit handled by resource managers is usually a transaction that may be committed or rolled back depending on the success or failure of the actions being part of the transaction.

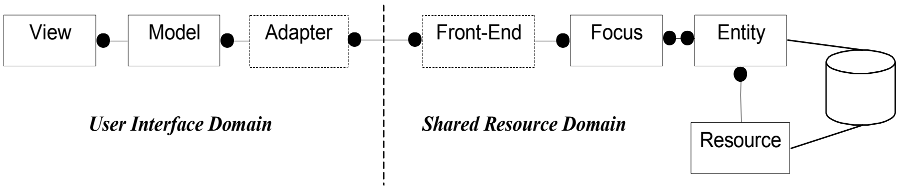

Figure 14. A CBO-based client/server architecture. The CBOs surrounded by a dashed line are invisible to the CBO programmer.

The shared resource domain typically accomodates a number of different *CBO* types – just like the user interface domain. Firstly, there will be a *front-end*[774]*,* which takes care of the communication with the *UID,* receiving requests and routing them to the appropriate *CBOs*. Also various related tasks, like authorisation of users, conversion of data formats and character sets, etc. may be handled by the front-end. In the same way as the adapter *CBO* of the *UID,* the front-end should be invisible to the ordinary *CBO* programmer, being a transparent part of the infrastructure.

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[771] In *Newi* and *BOF Lite,* such a file is referred to as a *View Layout File (VLF)*. *VLFs* are portable between different *GUIs*.

[772] [Sims94] p. 147

[773] [Sims94] p. 128.

[774] See. [Sims94] p. 96

The *entity CBO* (or *Enterprise DO, EDO)* is the *SRD* counterpart of the *model CBO* of the user interface domain.[775] An *entity* object typically represents a domain concept, such as customer, order, or the like. Although an *entity* object often handles one database table, it may as well represent a logical view in the database or a number of database tables – an order object consisting of a header and a number of order lines provides an example of this. The customary *CRUD* operations (create, read, update, delete) are usually made available by the *entity CBO*. The *entity CBO* may include code for checking that business rules are not violated and is often responsible for the preservation of referential integrity as well. A number of *entity CBOs* representing the same basic domain concept can also be used to provide different views of the same object.

Although the *UID model CBO* may interact with the *SRD entity CBO* directly, in many cases it will be preferable to introduce a *focus CBO*[776] (or *Transaction Coordinator DO, TDO)* as an intermediate between these.[777] The *focus CBO* is basically a transaction object, taking care of the access of one or more entities and providing commit scope for a number of actions. The *focus CBO* encapsulates a business process, like invoice creation or order entry. It may apply business rules and manage referential integrity, if this is not done elsewhere, e.g. in the *model CBO*. The *process-centric focus CBO* could be regarded as the *CBO* variant of an application, working on a number of *data-centric entity CBOs* by distributing a sequence of messages.[778] At times, the *focus* and *entity CBOs* may be combined into one *CBO*. This is particularly suitable, when no focus *CBO* needs to access more than one entity *CBO* during a transaction.[779]

Very often, there is a need to support a number of different database management systems. In this case, it will be advisable to introduce a layer of *resource CBOs* (or *Resource DOs, RDOs)* as well that contain the *SQL* statements through which the actual database accesses are made.[780] Such a layer is often referred to as a bridge, and each bridge will be tailored for a specific *DBMS* or for a separation layer such as *ODBC*.[781] If only one *DBMS* is handled, the *resource CBOs* may be collapsed into the entity *CBOs*. Trading some extra coding for resilience to change may, however, often be worthwhile, even though there may be no immediate need to support more than one database system. As a rule, there is a one-to-one mapping between *entity* and *resource CBOs*.

The organisation of the server domain into focus, entity, and resource *CBOs* is, of course, entirely conventional. The programmer is free to choose any other architecture he wants. As mentioned, the focus and entity objects may often be profitably amalgamated into one, and so may the entity and resource *CBOs*. If all three coalesce, we get one single *server CBO*.

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775 [Sims94] p. 98 et seq. See also id. op. p. 297 et seqq. and [Sims96e]. The model (or local model) object may be seen as a cached version of the entity object or parts of it.

776 In [SSA97b], *focus CBOs* are renamed *coordinator XOs*. See also [HS00] p. 361 et seqq. (cf. also p. 358 et seqq.), where *focus processes* somewhat akin to *focus CBOs* are made responsible for *business transactions*. [ES98] p. 171 et seq. uses the term *focus object* for the key abstractions in the object model. During analysis, these *focus objects* should be identified and grouped together with their various helper objects into *focus groups* that will map one-to-one to the *distributable component classes*.

777 [Sims94] p. 97 et seq. The *focus* and *entity* objects will be inspired by Jacobson's *control* and *entity* objects as described in e.g. [JCJÖ92] p. 134 et seqq. According to Jacobson, there are three object types: *interface objects, entity objects,* and *control objects*. *Interface objects* handle interfaces – in particular, user interfaces, of course – whereas *entity objects* encapsulate information. *Control objects* are responsible for actions – such as transactions – that cannot be tied to a certain object, but typically operate on a number of different entity objects. The purpose of this division is to achieve locality of change: Data are generally stable and so are entity objects, whereas changes will happen more frequently in functionality or user interfaces, affecting control and interface objects, respectively. Cf. [Sims94] p. 218 and 297 et seqq. The separation of *policy* and *implementation* methods recommended by [RBPE+91] p. 250 and p. 282 et seq. points in the same direction. Whereas policy methods should accommodate the variable, context-sensitive aspects of programme code, implementation methods harbour the stable, algorithmic content not so prone to change.

[ES98] p. 196 raises the question whether *TDOs* should be regarded as *SRD DOs* or *WFD (Workflow Domain) DOs* – the former alternative is hesitantly opted for. Another type of *SRD DO* called a *Query DO (QDO)* is also introduced here. The *QDO* is intended for read-only bulk queries that span many *EDOs* and bypasses the *EDOs* as well as the *RDOs* by directly accessing the database. As mentioned in footnote 769, [HS00] adds *Test DCs (TDCs) and Gateway DCs (GDCs)*.

778 Cf. [SSA97b] p. 24.

779 [Sims94] p. 104 et seqq. discusses whether it is preferable to have one instance of every entity for each transaction that refers to this particular entity or to have one shared instance of it. The former, multiple instances alternative, turns out to be the easier one to implement, whereas the latter, although generally preferable, makes it more difficult to avoid inconsistencies between transactions and will not be feasible, until a number of technical research problems have been resolved. Cf. also [HS00] p. 340 et seqq.

780 [Sims94] p. 99

781 [ES98] p. 195 suggests that, if possible, *RDCs* should be implemented generically and be driven by configuration files.

1.4.14 CLIENT/SERVER DESIGN CONSIDERATIONS

In Sims' vision of business objects, the *CBO* is the *shape* that really dovetails with client/server programming. Traditional monolith applications are too large-grained, causing the "fatal question" of "where to split" to be raised.[782] The ensuing *application partitioning* efforts tend to wind up doing extensive middleware programming. At the other end of the spectrum, distributed objects of the *CORBA* or *DCOM* species are too small-grained and technology-oriented. Although they may well be very fit for low-level "plumbing", they are much too complex to handle for business developers.[783] *CBOs* have the right granularity, feature complete local/remote transparency, are easy to use, and may be built by business programmers in their own language of choice.

Eeles and Sims consider four different client/server splits from the viewpoint of how the *presentation, application,* and *data (PAD)* aspects are distributed:[784] In the *single system* model, a single client holds all three parts. Consequently, both the *UID* and *SRD* are on a single client in this case. A *fat client* holds the *presentation* and *application* parts, leaving only *data* to the server, and a *thin client* holds only the *presentation* part and lets the server accommodate both the *application* and the *data* parts. In the *fat client* model, the *SRD* will extend into the client, whereas in the *thin client* model, the *UID WDOs* will be relocated to the server. The *distributed* model, on the other hand, splits the *application* part between client and server, but neatly keeps the *UID* on the client and the *SRD* on the server. The business object approach supports all these models, although the one undoubtedly preferred by Eeles and Sims is the *distributed* model.

In his books and a number of articles[785], Oliver Sims also treats a number of issues that will be encountered when designing client/server systems. Many of these are not specific to business object designs, and the ideas put forward, although valuable to anyone interested in client/server technology, are not as groundbreaking as those presented above. The topics covered include data placement, transaction and locking strategies, and the 'megadata' problem, i.e. how to handle large result sets and amounts of data.[786]

In large distributed client/server systems there may be many servers having different *scope,* where scope is defined as the range of users accessing the server.[787] A server may, for example, have enterprise, division, location, or department scope. Often it will be necessary to replicate data between servers to get acceptable performance. *Prime data* or *master data* represent the most current and trusted version of a certain set of data; such data should be placed as high as its scope or higher. *Business copy data* are snapshots of prime data, typically made for decision support applications and the like, where the freshness of the data is not absolutely crucial. *Operational copy data* are copies of prime data made in order to shorten response times and improve availability. *Operational copy data* are located at a lower level than the prime data they represent. One important example is the model object of the UID, being an operational copy of an entity object.[788]

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[782] [Sims97].

[783] [Sims96c]. Some of the difficulties at hand are considered in [WWWK94] and [ER97a].

[784] [ES98] p. 184 et seqq. Cf. also [Sims96g] p. 22 and [HS00] p. 496 et seqq.

[785] [Sims96e], [Sims97], [ES98] p. 203 et seqq.

[786] [Sims94] p. 180 et seqq.

[787] [Sims94] p. 155 et seqq.

[788] [Sims94] p. 168 enumerates four strategies for keeping model data synchronised with entity data:

- locking the prime data copied by the model object – the main drawback with this is that it will not allow other users to access the locked data
- refreshing model data immediately before using them ([Sims97] p. 60 mentions the variant of refreshing at intervals) – this approach causes much network overhead and cannot guarantee that data are up to date anyway
- refreshing model data whenever prime data change – framework-supplied interest registrations may be used to achieve this
- regarding model data as "work in progress", being potentially out of date as soon as they have been copied – this is in essence the optimistic approach to locking and implies that some transactions will fail because data were not current and that the model *CBO* will have to cope with such failures on a regular basis

Sims wisely commends the last two approaches and dismisses the second altogether.

A *resource manager* is a facility for handling transactions such as a *Database Management System (DBMS)* or a *Transaction Processing Monitor (TPM)*. The *Resource Manager Domain (RMD)* defines the scope where a resource manager may handle a commit.[789] A *unit of work (UOW)* is a number of changes that together make up a transaction and should be either committed or rolled back together. A very fundamental design rule asserts:

Every RMD unit of work should be started by a single message to the SRD.

This design principle is intended to enable the use of 'classical' atomic transactions. If an action needs to be undone later, this could be done through a special 'undo' transaction, effectively acting just like a *journal entry* in bookkeeping. Different locking strategies – optimistic or pessimistic – can, of course, be applied.[790] If locking (also known as 'check-out') is taken advantage of, the problem of lingering locks must be considered.[791]

The 'megadata' problem refers to the difficulties encountered when handling very large sets of data.[792] A user may, for example, inadvertently or on purpose, send off a query that may return a result set, which consists of thousands of records. Such queries may choke network communications, cause considerable presentation problems, and may cause an excessive amount of *CBOs* to be created on a client machine. These problems may be countered in a number of ways. For example, high-level indices may be created to the data, and tabs or tree hierarchies may be used to organise the data visually.[793] At the *CBO* level, *ghost objects* may be used, as outlined above (p. 161).

1.4.15 ENCAPSULATING BUSINESS PROCESSES

When objects are freed from the fetters of the monolithic application of yore, it is no longer obvious where the *business process,* i.e. the glue functionality once embodied inside an application, is to be encapsulated.[794] There are two kinds of interface objects that may take on this rôle, forms and folders.[795]

To enclose a business process within a *form* is often very straightforward. Sometimes, however, a number of *CBOs* are involved in one business process, and a new object may be required to encapsulate and take the responsibility of the process. One example of this is the transfer of money from one account to another. By introducing a transfer slip *CBO,* we avoid the quandary about which of the two accounts involved ought to implement the user interactions involved and send the update request to the *SRD*.

Folders are useful encapsulators of business processes when there are several closely related objects involved in a process. The folder could, for example, represent an insurance case including the forms and letters involved in the case. Often a number of modifications to such objects should be sent off to the *SRD* in one transaction, which could be done from the folder object enclosing the other objects. Alternatively, a special *'unit-of-work' object* responsible for a certain transaction could be introduced. The objects involved in the task will then have to send change notifications to this object, as well as *begin transaction* and *end transaction* commands.

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789 [Sims94] p. 166 et seqq.

790 [Sims94] p. 173 et seqq.

791 When users lock data in order to get exclusive access to them, there is always a risk that the data will not be properly unlocked because of system crashes, programming errors, power outages, etc.

792 [Sims94] p. 180 et seqq. Cf. also [ES98] p. 84 and p. 206 et seqq., [HS00] p. 314 et seqq., and [Coll95] p. 357 et seq.

793 [Sims94] p. 186.

794 [Sims94] p. 189 et seqq. [ES98] p. 107 et seqq.

795 In [ES98] loc. cit. a somewhat different approach based on *activity distributable objects* (or *activity DOs* for short) is presented. In the example given of such an *activity DO,* an attractive and novel user interface design is used, mimicking a *UML Activity Diagram* (see *Figure 11*). It is emphasised that there is no sharp division-line between *data-centric* and *process-centric* business components, just a continuum between the two extremes. Cf. also [HS00] p. 172 et seqq.

Some *CBOs* may become too big to be useful. Different aspects of the object may then be split between different model, view, and focus objects, whereas the entity object will remain unsevered, embodying the unity of the concept implemented. A *CBO* may also be made context-sensitive, changing its behaviour to suit its container environment or perhaps the skill level of the user who avails himself of it. A *CBO* may also aggregate a number of *role objects,* each implementing a certain conceptual aspect of the owning *CBO.*[796] *Employee, Customer,* and *Patient* may, for instance, be such role objects, belonging to a core *Person* object.

1.4.16 THE *SSA* BUSINESS OBJECT FACILITY SUBMISSION

The *OMG BODTF* effort will be subject to scrutiny in a separate section below, but since the *SSA* proposal submitted in response to the *BODTF business object RFP* closely reflects Oliver Sims' vision of business objects and the ideas embodied in the *Newi* system, I have chosen to treat it here rather than in the *BODTF* section.[797] Furthermore, the focus will be on the aspects and issues where the *SSA* proposal departs from or extends what has already been set forth.

The *SSA* proposal was in a sense the odd man out among the *BODTF* submissions. Its emphasis on surface area reduction, its exotic semantic messaging facilities, and its inherent hostility towards *IDL* interfaces all ran counter to the *CORBA* spirit. The use it made of *CORBA* and the *CORBAservices* was as a pure substructure, from which the business programmer was to be almost entirely shielded. In contrast, the *BODTF* activities eventually came to revolve around a kind of super-*IDL,* the *CDL (Component Definition Language)* specification language, which rather would have raised the surface area of *business objects* to a level as yet unheard-of. Although the *SSA* proposal was arguably the most innovative of the *BODTF* submissions, nay, evidently too radical in its approach to gain acceptance through a consensus process, such as that of *OMG,* it also set itself apart from the competition by being based on an industrial-strength implementation, which, it appears (at least to the present author), both provided this submission with a more solid, well-proven foundation and made for a far greater technical depth than can be found in most of – if not all – the other *BODTF* proposals.

1.4.16.1 Terminology

Laudably, the *SSA* submission defenestrated the vague and ambiguous term *business object* and its rather ungainly acronym sibling *CBO (Cooperative Business Object)* and instead adopted the term *XO (eXecutable Object),* which should be more telling and to the point. The *Semantic Data Stream (SDS)* was likewise renamed *Semantic Data Object (SDO),* and *focus* objects were called *coordinators.*

1.4.16.2 Restrictions

Just like the other *BODTF* submissions, the *SSA* proposal did not deal with the presentation aspects of business objects, although the idea of an *Object-Based User Interface (OBUI)* really is a keystone of Oliver Sims' business object vision. This omission was obviously due to the regulation in the *RFP* that *business objects* should be kept isolated from presentation and storage mechanisms.[798]

Additionally, it is pointed out in the proposal that to enable the ad hoc integration necessary for a component market to form, binary standards are needed.[799] Since *OMG* rigorously prohibits implementation

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[796] [Sims94] p. 199 et seq.

[797] The original submission [SSA97a] and the revised version [SSA97b] do not differ very much. *SSA* has also submitted a slightly revised version [SSA97c] of its *BODTF* proposal [SSA97b] in reply to the *CORBA* component model *RFP* [OMG97m]. [SSA98] is a related submission to an *OMG* "tagged data" *RFP* [OMG97q] (errata list [OMG98a]). The standpoint of these documents is also reflected in Eeles' and Sims' book [ES98], although the book is not altogether co-ordinated with the submissions terminologically and otherwise.

[798] See below p. 181.

[799] For example in [SSA97b] p. 39.

details from being given in specifications, such a binary interface was not included in the *SSA* submission, but it would have been quite simple to extend it so as to include such a binary interface.

The *SSA* proposal, being a specification of a *Business Object Facility,* did, of course, not offer a general account of client/server design like that in Oliver Sims' book. Rather it is focused on the task of infrastructure specification and, in particular, on the question of how a *Newi*-style *business object facility* could be built on a *CORBA* foundation.

1.4.16.3 Architecture

The *SSA BOF* consists of:

- the *XO* framework, being a *CORBA*-based infrastructure providing the necessary support for the *XO programmer's model* and hiding various troublesome design concerns such as "local/remote transparency, design for minimizing network traffic, thread and serialization management, memory management and the resolution of externally meaningful object names"[800]
- *BOF Services,* comprising various high-level services (built on top of *CORBAservices)* that support persistence, relations, transaction and event handling, etc.
- an *Information Exchange Facility* that provides support for message exchange together with semantically tagged data
- some useful standard *XOs,* including a *Base,* a *Collection,* and a *Coordinator XO*

The above constituents all contribute to a simple *XO programmer's model* suitable for business developers and domain experts rather than for technology pundits.

1.4.16.4 The XO Programmer's Model

The *XO ontology,* i.e. the items that to an *XO* developer appear as specific to *XO* programming, encompasses:[801]

- *XOs,* i.e. the business objects themselves[802]
- *requests (BofRequest* objects), which are used for all interoperations between *XOs*
- *SDOs,* the *Semantic Data Objects,* which are used for data exchange and contain semantic meta-data and type information in addition to data
- *atoms,* which are unique numbers representing strings – atoms are used in the *SSA* submission as a means to reduce the overhead caused by the employment of strings to encode message names, semantic labels, type information, etc.[803]

The *XO* programmer's model as presented in the *SSA* submission is conceptually the same as the *CBO* programmer's model described above. Let us recapitulate the main features:

- *XOs* are independently executable objects
- *XOs* are instances of business object classes that may inherit other *XO* classes
- *XO* classes are themselves objects and may have class methods and class data

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[800] [SSA97b] p. 13

[801] [SSA97b] p. 18.

[802] See section 1.4.3 on p. 146 above.

[803] [SSA97b] p. 22 and p. 38 suggests the use of atoms to handle synonyms and homonyms.

- *XO* inheritance hierarchies are freely configurable, may be restructured dynamically at run-time, and may cross process and machine boundaries
- *XOs* are identified by a class name and an instance name[804]
- *XO* class names are bound to implementations by means of configuration and the bindings may be changed as needed
- *XOs* have single entry-points and, thus, may be written in (almost) any programming language, including procedural languages and interpreted scripting languages
- *XOs* interoperate with full local/remote transparency through the exchange of *requests* that consist of a message name together with semantically tagged parameter data packaged in *Semantic Data Objects (SDOs)*[805]
- inter-*XO* messaging may be synchronous as well as asynchronous
- inter-*XO* messaging supports peer-to-peer conversations, which may imply that one *XO* is part of more than one thread of execution, although the *XO* programmer does not have to be concerned about the synchronisation complexities this may cause
- *XOs* are *serially reusable* and use the *synchronous non-blocking messaging* model, thereby avoiding the risk for deadly embrace situations and relieving *XO* programmers of the need to deal with difficult blocking considerations
- *XOs* do their own method dispatch whenever a message arrives
- *XOs* may send messages to themselves as well as to superclasses
- *XO* activation, deactivation, instance data management, memory allocation, garbage collection, error handling, etc. are transparently handled by the *BOF* infrastructure

XOs communicate by means of *BofRequest* structures, taking advantage of a "Request" pattern similar to the well-known *Command* pattern.[806] The *BofRequest* objects contain an identifier for the receiver and another for the sender, the message name, the message data wrapped in an *SDO,* and, optionally, a reply *SDO*. Additional data may be appended to the request such as the instance data of the target *XO*. This is one possible way to supply each instance of an *XO* class with unique instance data.[807]

The *SSA* proposal suggests two common types of server-side *XOs*, data-centric *entity XOs,* and process-centric *coordinator XOs* (the latter correspond closely to Sims' *focus CBOs).* Whereas the former function as pure data wrappers, embellished with some data validation functionality and the like, the latter co-ordinate the messages sent to the entities and enforce various rules related to the sequencing of messages. Important *coordinator XO* types are *transaction coordinators* and *workflow coordinators.*

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[804] [SSA97b] p. 59 et seq. elaborates this naming scheme by making class and instance names sequences consisting of up to three strings and by adding a prefix "BOF" and a *format identifier,* currently always being "1". Hence, the *external format* of an *XO name* is:

BOF □ 1 □ Class name □ Instance name

In most cases, "BOF" and the format identifier, "1" by default, may be omitted. Class and instance names have the tripartite form ($string_2$ and $string_3$ are optional):

$string_1$ | $string_2$ | $string_3$

Some examples of valid *XO* names are: Invoice □ 999837
Employee | Manager □ J.Doe

This naming scheme differs from *Newi* naming as described in footnote 739 on p. 154.

[805] Cf. footnote 728 p. 153.

[806] See [SSA97b] p. 19. [GHJV94] p. 233 gives an account of the *Command* pattern.

[807] Since all instances of one *XO* class share the same *DLL* or executable file, they also share the same global data. Thus, they need some form of infrastructure support for instance data. [ES98] p. 223 et seqq. suggests one model for such infrastructure support of instance data. Cf. above p. 159.

The semantic interfaces of *XOs* can be published in a ***semantic repository,*** although this possibility is only suggested and not made out in detail.[808] *XOs* might also need to be packaged together with other *XOs* and e.g. help and documentation files. This could be done by assembling the related items into an *XO Deployment Package.*

1.4.16.5 The XO Framework

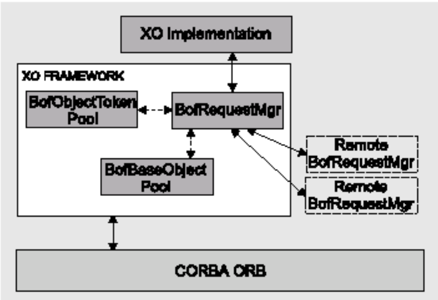

Figure 15. The XO Framework (courtesy of SSA Inc.)

The *XO Framework* is the *CORBA*-based infrastructure that makes the *XO* programmer's model come to life. For instance, it provides the necessary support for messaging – including non-blocking synchronous messages –, activation and deactivation of *XOs,* garbage collection, extensibility through inheritance, etc. It exposes itself to the *XO* programmer through a number of *CORBA* interfaces/classes that will be examined somewhat closer below.

The big picture is given by *Figure 15.*[809] *XOs* do all their messaging through the ***send*** and ***post*** methods of the local *BofRequestMgr.* For each call of ***post*** or ***send*** the *BofRequestMgr* creates a *BofRequest* object and either delivers it directly to a local *BofObject,* i.e. the *CORBA* representative of a certain *XO,* or forwards it to a remote *BofRequestMgr.*[810]

BofBaseObject is the common ancestor of *BofObject* and *BofRequestMgr* and only contains the single operation *execute,* which is invoked by a *BofRequestMgr* object in order either to deliver a request to a local *XO* or to forward it to another *BofRequestMgr*[811]*:*

```
interface BofBaseObject {
   BofResult execute(inout BofRequest request);
};
```

There is a *BofBaseObject* pool managed by the local *BofRequestMgr.* Since the *BofBaseObject* interface is inherited by both *BofObject* and *BofRequestMgr,* it would seem possible for the local *BofRequestMgr* to use the *BofBaseObject::execute* method to send messages both to local *XOs* – represented by the former type of objects – and to remote ones – represented by the latter type. Because of ***inter alia*** marshalling concerns, this is not altogether true, as will be made clear below when discussing the *BofRequestMgr* interface.

BofObject is a *CORBA* object encapsulating a particular *XO* and acting as an intermediator for messages to the *XO,* which are delivered to it through the invocation of the *execute* method inherited from its *BofBaseObject*

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808 [SSA97b] p. 25

809 [SSA97b] p. 55

810 How *BofRequestMgr* objects find out about each other is a matter of implementation. [SSA97b] p. 56 suggests two possibilities, viz. having a central *BofRequestMgr* pool or making each *BOF* responsible for locating other *BOFs* as needed. [SSA97b] p. 73 presents an optional *BofRequestMgrPool* interface, containing methods providing support for registration of and search for the *BofRequestMgr* in charge of a particular *XO.* Additionally, an *XO* registration may be revoked:

```
interface BofRequestMgrPool {
     void AddBofRequestMgr(in BofRequestMgr mgr,in BofObjectName name);
     void RemoveBofRequestMgr(in BofObjectName name);
     BofRequestMgr LocateBofRequestMgr(in BofObjectName name);
};
```

811 Cf. [SSA97b] p. 57. *BofResult* is defined thus:

```
enum BofResult { Okay, Error, Unsupported, FailedToRoute, NoObject, Memory };
```

parent.[812] *BofObject* overrides *execute* and furthers the requests to the *XO* proper. There is exactly one *BofObject* for each *XO:*

```
interface BofObject : BofBaseObject {
   BofResult Super();
   BofResult Self(in CfInfoExchange::Atom method,
                  in CfInfoExchange::Sdo data,
                  in CfInfoExchange::Sdo reply);
};
```

Through the *Super* and *Self* methods, an *XO* may forward a request to its ancestor or send a new message to itself.

BofObjectToken is a "local representative" of an *XO* and is used as an identifier of this particular *XO* inside other *XOs.*[813] It holds the name of the *XO* it represents and a handle of the *CORBA* object (a *BofObject* or a *BofRequestMgr* object depending on whether the *XO* is local or remote) through which messages are sent to the *XO:*

```
interface BofObjectToken {
   exception CannotAcquireHandle {};
   readonly attribute BofObjectName name;
   readonly attribute BofBaseObject handle;
   readonly attribute boolean represents_remote_object;
   BofBaseObject AcquireHandle(in BofRequest current_request)
                 raises (CannotAcquireHandle);
   void ReleaseHandle();
};
```

Both local and remote *XOs* are represented by *BofObjectToken* objects. An *XO* referred to through a *BofObjectToken* may not be currently active or reachable or may not even exist. Not until a message is sent to the *XO,* needs the "real thing" – i.e. the *BofObject* and the *XO* proper – to be activated and connected to. This is only done, when the *BofRequestMgr* invokes the *AcquireHandle* method. *BofObjectToken* objects are allocated by the *BofRequestMgr* from a pool, the exact nature of which is left as an implementation exercise.

A *BofRequest* is a message structure holding various data items such as destination and sender identifiers, a method name (in the form of an *atom,* i.e. a numerically coded string), a *Semantic Data Object (SDO)* for parameter data, another optional *SDO* for reply data, etc.[814]

```
struct BofRequest {
   BofObjectToken target;
   CfInfoExchange::Atom method;
   CfInfoExchange::Sdo data;
   CfInfoExchange::Sdo reply;
   BofObjectToken source;
   long flags;
   any post_context;
   BofResult PostResult;
   BofTxID current_tx;
};
```

The *BofRequestMgr* is the object called by *XOs* when they need to *send* or *post* messages:[815]

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[812] [SSA97b] p. 60 et seq.

[813] [SSA97b] p. 57 et seqq.

[814] [SSA97b] p. 65 et seq. The *flags* argument indicates such issues as whether a request was sent or posted. The *post_context* argument is used to supply the poster of a request with an identification of the reply (see footnote 815). *PostResult* is the *BofResult* of a posted message, and *current_tx* gives the transaction context. For a general discussion of *CBO*-style messaging, including the arguments involved, see above p. 151 et seqq.

[815] [SSA97b] p. 61 et seqq. Most of the parameters to *send* and *post* should be self-explanatory. The *current_request* argument is the *BofRequest* currently handled by the calling *XO,* whereas *post_context* holds data that will be inserted into the reply by the *BOF* infrastructure to enable the posting *XO* to identify the reply. More details are given in [SSA97b] p. 62 et seqq.

```
interface BofRequestMgr : BofBaseObject {
   exception PostBagFull {};
   BofResult send(in BofRequest current_request,
                  in BofObjectToken target,
                  in CfInfoExchange::Atom method,
                  in CfInfoExchange::Sdo data,
                  inout CfInfoExchange::Sdo reply);
   BofResult post(in BofRequest current_request,
                  in BofObjectToken target,
                  in CfInfoExchange::Atom method,
                  in CfInfoExchange::Sdo data,
                  in CfInfoExchange::Atom callback_method,
                  in any post_context) raises (PostbagFull);

   BofObjectToken register_object(in BofObjectName name);
   void deregister_object(in BofObjectToken token);
   BofObject AcquireBofObject(in BofObjectName name);
   void ReleaseBofObject(in BofObjectToken token);

   BofResult execute_remote_request(inout BofRemoteRequest request);
};
```

When either of the *send* and *post* methods has been invoked, the *BofRequestMgr* creates a *BofRequest* package, initialises it, and routes it to its – local or remote – destination by calling its own *execute* method. During this process, it may activate a local *XO,* create its *BofObject,* and pass the *BofRequest* object to it by calling the *execute* method of the *BofObject.* If the *XO* is remote, it will further the request to the remote *BofRequestMgr* by calling its *execute_remote_request* method.[816]

The *BofRequestMgr* is also needed to retrieve an identifier of another *XO* in the form of a *BofObjectToken.* This is done by calling the *register_object* method, which should be mirrored by a *deregister_object* call when the object is no longer needed. Sometimes, an *XO* may need a reference to its own *BofObject,* which may be retrieved and released by calling *AcquireBofObject* and *ReleaseBofObject.* The *register_object, AcquireBofObject, deregister_object,* and *ReleaseBofObject* methods make possible *COM* style reference counting and garbage collection. Reference counts are always local, implying that a *BOF* will only handle references to its own local *BofObject* and *BofObjectToken* objects. There is one *BofRequestMgr* for each *BOF,* and there is one *BOF* for every machine.

1.4.16.6 The BOF Services

The *SSA* submission also contains the specifications of the *XO* event, externalisation, life cycle, persistence, relationship, and transaction services.[817] These *XO* services are on a higher level than their *CORBA* counterparts, which, however, may be taken advantage of for their implementation, and they are accessed through *XO* style semantic messaging.

Many of the services are supplied through the *BOF*-provided *Base XO* superclass, which is inherited by all *XOs.*[818] For instance, the *Base XO* class incorporates support for relationship management[819] and life cycle handling[820]. Let us now look a little closer at the different services.

Relationship semantics may be either "strong" – *aggregation* or *containment* – or "weak" – *associations.*[821] Aggregated objects are real parts of their containers. Life cycle operations on the container objects will be

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[816] [SSA97b] p. 72 et seq. There is a special variant of the *BofRequest* structure for remote invocations, the *BofRemoteRequest.* This differs from the regular one in a number of respects, the most important of which will be that it uses serialised *SDOs,* as there was no support for passing arguments by value in *CORBA* at the time when the submission was put together.

[817] [SSA97b] p. 30 et seqq. and p. 75 et seqq. Cf. also [ES98] p. 257 et seqq. In addition to the services mentioned, naming, trader, and rules services are suggested as being "relevant to a business developer" by [ES98] p. 266 et seq.

[818] [SSA97b] p. 107 et passim

[819] [SSA97b] p. 95 et seqq.

[820] [SSA97b] p. 86 et seqq.

propagated to aggregatees, and, consequently, they will be moved and deleted together with their owning *XOs,* whereas associated objects maintain their life cycles independently. All relations are two-way, persistent, and have many-to-many cardinality. Objects taking part in a relationship may be assigned *roles*. Only binary relations are supported. Relations may be manipulated and queried through the *Base XO* interface, which provides default support for the *CreateRelationship, ChangeRelationship, DiscardRelationship,* and *Query* messages. The default implementation used in *Base XO* stores the relation data in the *XO* that receives the *CreateRelationship* message and then sends off another *CreateRelationship* message to the other *XO* involved.[822]

As a part of life cycle management, messages are sent to an *XO* when it is created *(Initialize)* [823], deleted *(RequestDiscard* and *Discard)*[824], activated *(Activate)*[825], or deactivated *(Deactivate)*. The *XO* may indicate its acceptance or disapproval of these life cycle actions in its reply if it likes to; otherwise, the *Base XO* may supply default behaviour and a default reply. There are other life cycle messages for copying *(Copy* and *CopyInstance)* and moving an object *(MoveInstance)*. *CopyInstance* and *MoveInstance* are class methods, sent to the *XO* class rather than to an *XO* instance, and may be employed in order to copy or move an *XO* across process boundaries. Being class methods, these two operations may be performed without the *XO* to be copied or moved having been activated.

The *XO externalisation service* supports the externalisation of semantically tagged data.[826] When an *Externalize* message arrives, an *XO* supporting externalisation should return an *SDO* with its own state data, and when the *Internalize* message arrives, it should initialise itself from the data in the supplied *SDO*.

The *Persistence Manager XO* co-operates with the *Base XO* class to provide support for persistence.[827] The *Base XO* by default implements the persistence messages *Store* and *Restore* by sending *Externalize* and *Internalize* messages to the current *XO*.

Another *BOF*-provided manager *XO* is the *Event Manager XO,* which provides a *push* model *publish-subscribe* event service.[828] *XOs* acting as *event consumers* subscribe to particular events (issued either by any *XO* or by a particular specified *XO)* by sending *RegisterInterest* messages to the event manager.[829] When an event has happened, the event supplier *XO* concerned sends a *TriggerEvent* message to the event manager together with its own *XO* name, the event name, and any event data. The event manager will then relay a *Notification* message to all *XOs* that have registered interest for the event in question. It is also possible to query the event manager about all pending registrations.

There are also some *life cycle notifications* that will be triggered by the *Base XO: Discarded* is triggered by an instance when it is discarded, and *InstanceCreated* and *InstanceDiscarded* are triggered by a class whenever an instance is created or removed.

As mentioned above, a *transaction coordinator XO* may be used as a *transaction client* in order to control a transaction involving a number of *XOs* acting as *transaction servers*.[830] The *SSA* submission proposes a generic

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[821] This distinction is also made by e.g. [RBPE+91] p. 57 et seqq.

[822] *Hop counts* are used to avoid propagating such messages between *XOs* forever.

[823] According to [SSA97b] p. 86, an *XO* is created, when the message *Create* is sent to its *XO* class object.

[824] The difference between *RequestDiscard* and *Discard* is that the former is a request, which the *XO* may choose to disapprove of, whereas the latter is non-negotiable and only offers the *XO* an occasion to do any necessary clean-up. [ES98] p. 258 only recognises a *Discard* method – but with the semantics of the *RequestDiscard!*

[825] There are actually three different activation messages: *Activate, ActivateClass,* and *ActivateObject*. The details of *XO* class and object activation are given in [SSA97b] p. 69 et seq. and p. 91 et seq.

[826] [SSA97b] p. 85 et seq.

[827] [SSA97b] p. 93 et seqq.

[828] [SSA97b] p. 78 et seqq. The *pull* model, implying the use of polling, is deemed "to be of limited use in business systems".

[829] There is also a *DeregisterEvent* message, through which an interest registration is cancelled. An *event consumer* may also register its interest in an event directly with the *XO* concerned. The *Base XO* method handling the message will, however, probably be implemented so as to forward such a registration request to the event manager.

[830] [SSA97b] p. 100 et seqq.

Coordinator XO that may be configured with the names of the *XOs* involved in a transaction and the messages to be sent to these *XOs*.[831]

A *BOF*-provided *Transaction Manager XO* is used by the *Coordinator XO* or other transaction clients for transaction bookkeeping, as a safeguard against deadlocks, and for two-phase commit/rollback handling. The *Transaction Manager XO* supports the *BeginTransaction* and *EndTransaction* messages, which should surround any transactional operations, as well as *RegisterObject,* through which one or more *XOs* are registered as participants of a transaction.

Whenever the *EndTransaction* message arrives, the *Transaction Manager XO* sends the *PrepareToCommit* message to all *transaction server XOs*[832] taking part in the transaction, and if all *XOs* assent, it will hereupon issue the *Commit* message to all the *XOs*. If any *XO* does not reply affirmatively to *PrepareToCommit,* a *Rollback* message will be sent to all *transaction server XOs* instead. Only *XOs* supporting the three messages *PrepareToCommit, Commit,* and *Rollback* are capable of participation in a transaction. In some cases, such support may be introduced by inheritance.[833] Nested transactions are not supported, and posted messages are not deemed parts of a transaction.

1.4.16.7 The Information Exchange Facility

The *Information Exchange Facility*[834] supports the semantic messaging mechanism used by *XOs* and described at some length above.[835] The blocks of data exchanged in this kind of messaging are referred to as *Semantic Data Objects (SDOs).* In the *SSA* submission, the term *SDO* is used variously to signify such a data package in its entirety and each of the constituents that are part of it. An *SDO* (in the latter "itemised" sense) has the attributes *label, value, type,* and *container*. The notation used to display the contents of *SDOs* is exemplified below (a container is any item delimited by curly brackets):

```
{
    [Label, Type] "Value"
    {
        [Label2, Type2] "Value2
    }
}
```

The containers make it possible to nest *SDOs*. Above, *Label2, Type2,* and *Value2* are parts of a nested *SDO*. All attributes are optional, and if no type is specified, the type of the value defaults to *String*. There is a comprehensive *CORBA* interface designed for the manipulation of *SDOs*. Other interfaces support *SDO* factory functionality and conversions between different *SDO* types. All *XOs* should support the *Set* and *Query* messages, in which the accompanying *SDO* labels specify the attributes to be set or queried.[836] If a *Query* message is issued with no attribute labels specified, all the attributes of the *XO* should be returned.

Atoms, i.e. numerical coded strings, are used to represent *SDO* labels and *BofRequest* message names. Atoms may be used to support synonyms and homonyms and are inherently more efficient than strings. There is an *AtomManager* interface supporting the registration of atoms and the retrieval of strings represented by atoms.

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[831] The description of the *Coordinator XO* given in [SSA97b] p. 106 and p. 109 et seq. is incomplete. All details about the scripting language and the externalisation format essential for its proper functioning are, for instance, postponed to "subsequent RFPs".

[832] As is the case with *CORBA OTS,* there are two kinds of transaction servers: *Recoverable servers* are *XOs* that take full part in the transaction and have state that may be committed or rolled back. *Transactional servers,* on the other hand, do not have recoverable states and ignore *Commit* and *Rollback* messages. Nevertheless, a transactional server may prevent a *commit* by returning a not-OK reply in response to *PrepareToCommit*.

[833] [SSA97b] p. 32

[834] The need for such a facility as a part of the *CORBA Common Facilities* was identified in [OMG95a] p. 47 et seqq. A "tagged data" *RFP* [OMG97l] was later issued by *OMG,* but miscarried. [SSA98] was submitted by *SSA* in reply to this *RFP*.

[835] In section 1.4.6 on p. 151.

[836] [ES98] p. 225 et seqq.

1.4.16.8 XOs Provided by the BOF

Most *XOs* provided by the *BOF* have already been lit upon.[837] These include the *Base XO* inherited by all other *XOs*[838], the *Coordinator XO* used to control e.g. transactions, and the event, persistence, and transaction manager *XOs*. There is also a special *BOF XO,* from which user *XOs* may retrieve references to various "well-known objects" such as the managers needed when using the *BOF Services,* and a *Collection XO* that offers *XO* style bag and set data structures.[839]

1.4.17 CODA ON SIMS' BUSINESS OBJECTS

One may construe Oliver Sims' business object vision as a revisitation, revival, and re-application of the grand vision of object-orientation first dimly conceived by Ivan Sutherland and the *SIMULA* creators in the 60s and brought to its full fruition by Alan Kay and his comrades-in-arms at *Xerox PARC* in the 70s. Much in the same vein as these pioneers, Sims set out to create an object-oriented microcosm inside the computer, the inhabitants of which are *objects,* interacting with each other through late-bound messages and with the users through an object-based *graphical user interface.* To Sims and Kay alike, object-orientation ultimately transcends the parochial confines of a useful programming technique and metamorphoses into a general philosophy, not to say epiphany, which aims at the amplification of human reach by the leverage of a number of fundamental ideas and principles. In both visions, a naïve *user* is the focus of interest – the *Smalltalk* developers primarily had a *child* in mind, Sims an ordinary *business user.* Indeed, this apparently minor difference in coign of vantage accounts for much of the dissimilarities in the touch and flavour of Sims' approach from that of Kay's.

The *Xerox* endeavour was a research effort, and the researchers at play could make any simplifications that were to their taste and advantage. Their successors have largely been set on attending to the various white spots that consequently were "left as an exercise", including issues such as legacy integration, language diversity, operating system and database interfacing, performance, multitasking, object distribution, object persistence, etc. In many cases, these 'patching' efforts have implied trading purity for usefulness. Oliver Sims' *business object* vision differs from the *Xerox* vision by descending from an environment where some of these issues matter very much and where the serene purity of a uniform integrated environment such as *Smalltalk* will seldom be considered affordable.

What sets Sims' endeavour apart from other object-oriented developments is mainly his insistence on *loose coupling* leading forward to his very radical attempt to dismantle the traditional application and set its constituent objects free. The resulting independently executable, large-grained, syntactically decoupled, but semantically tightly-coupled *cooperative business objects* constitute a distinctly novel breed of denizens of the digital computer and may perhaps inaugurate a new era of atomised, anthropomorphic organisation of computer software – if *anthropomorphic* is taken to mean "reflecting man's cognition of the world". I will suggest below that a new paradigm of computing, which I call *realistic computing,* can be formed on the basis of *Newi*-style *business objects* and 3-D user interfaces.[840]

On the other hand, Sims' vision has not so far been conspicuously successful in terms of either mind or market share, and judging from his own gradual distancing himself from it in his recent writings he has largely lost faith in it himself. However, the inherent shortcomings of this vision – whatever these may be – are hardly what occasioned its failure to gain a footing. Rather, *SSA* is not one of the big players in the software playground, and, although it might have put *Newi* to good use in its own development efforts, it lacked the clout to make something as radically novel and out of the ordinary as *Newi*-style *business objects* conquer the world. Additionally, the attempts to have these *business objects* catch the wind by proposing a *CORBA*-based infrastructure for them in reply to the *OMG BODTF business object RFP* also came to naught, as did eventually

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[837] [SSA97b] p. 34 et seq. and p. 106 et seqq.

[838] [SSA97b] p. 122 gives a hint of what will be in the *Base XO*. Additionally, a distinction is made between *message* and *method:* A *message* will usually be implemented by a class provided by the *BOF* – in most cases this class will be the *Base XO* –, whereas a *method* must be implemented by the *XO* itself. Most *BOF service* operations are *messages*. *Externalize/Internalize, Set/Query, TriggerEvent,* and *PrepareToCommit* are examples of *methods*.

[839] Bags permit duplicates, whereas sets disallow them.

[840] See below p. 215.

the entire *BODTF* effort, thereby also delivering the death blow to any empyreal expectations about the future of *Newi*. Considering the current lack of appreciation for Sims' approach, the question must be raised if it was not just a cul-de-sac rather than the as yet misunderstood vanguard of computing. Only the future can tell for sure, although in order to be able to speculate intelligently about what it will tell and to propose a programme of future research[841], we will need to consider and contemplate also the darker sides of this technology. Aside from strategic mishaps, such as the *BOMSIG/BODTF* endeavour, and the exiguity of the companies behind *Newi*, what are the weaknesses of *Newi*-style business objects? Some issues that come to mind are:

1) *Proprietary infrastructure. Newi,* being architected and put together before the heyday of distributed objects, necessarily had to rely upon a proprietary infrastructure, which limited its appeal when the big players *(Microsoft, Sun, OMG)* a little later presented their new technologies and standards in this field. The *SSA BODTF* submission attempted to re-implement *Newi* on a *CORBA* basis, but since *CORBA* is a server-oriented technology, this attempt was not able to do justice to the *OOUI* foundation of the *CBO* vision, which, in our view at least, constitutes much of its allure. Will it be possible to retrofit the ideas from *Newi* on a mainstream technology foundation that also is capable of providing for the user interface aspects, such as, for example, *Microsoft's DNA* or *.NET?*

2) *Unprepossessing user interface.* The original user interface of *Newi* was designed in the *OS/2 CUA* fashion of the early 90s, and made heavy use of the rather maladroit *MDI*-style of visual integration, which later went out of vogue – for good reasons, one might be inclined to think. Although the *Newi* user interface was later modernised in the *Windows 95* style, it retained a somewhat old-fashioned and jejune look and feel, notably lacking support for *compound document* interactions. The rather pedestrian manifestations of *Newi business objects* as plain icons and form windows, with which users interact through the ordinary *GUI* repertory of clicks, double-clicks, drag-and-drop, and forms fill-in, contrast with Sims' grandiose vision of the computer as a small world inhabited by thing-like *business objects*. How can the outer appearances and interaction styles of *business objects* be enhanced to better reflect the profundity of this vision? Can they be adapted to latter-day *GUI* techniques, such as *compound document* and *web browser*-style interfaces? May 3-D user interfaces and virtual reality technology provide a good match for *business objects?*[842]

3) *Doubtful relation to components and RAD.* The *Newi* approach did not sort very well with what turned out one of the most important tools of the programming trade of the 90s, viz. component-based *RAD* environments, such as *Visual Basic, PowerBuilder,* or *Delphi.* What is the relationship between visually and programmatically tightly integrated components of the *ActiveX* or *JavaBeans* type and the more loosely knit race of co-operative *Newi*-style *business objects?* Can both styles of integration be supported by *Janus-faced objects,* as we suggested above?[843]

4) *Semantic messaging concerns. Semantic messaging* is the linchpin of Sims' *business object* vision, but this interoperability mechanism met with much incredulity in *BODTF* and has only later started to become more generally appreciated, largely as a consequence of the current *XML* euphoria. For one thing, semantic messaging is often alleged to be inefficient and too ungainly for programmers to handle. Additionally, semantic standardisation is necessary for interoperability between independently developed business objects. How much weight shall be attached to these complaints? What can be done to counter the problems?

5) *Lack of user interface flexibility. Business objects* are intended to be useful across application areas, but the requirements of different application areas will obviously be very different. For example, a *business object* representing a human being should disclose and elicit different

[841] [ES98] p. 269 et seqq. also give various suggestions about future directions for *business objects* with reference to as diverse areas as the (then still expected) *OMG BOF* standard, the web and *Java,* components and agents, meta-data, compound documents, DBMS technology, fault-tolerance, messaging, transaction management, workflow, and even chaos theory.

[842] See below p. 259.

[843] See p. 120.

pieces of information depending upon whether it is involved in the context of a medical record registration, a salary calculation, or a purchase transaction over the *Internet*. It would seem that a generally useful *business object* would need to support different *roles* or *views* and would require adequate protection of sensitive data lest they be divulged in contexts where they should not. How can such flexibility be supported? Can an easily configurable user interface be achieved through existing technology, such as e.g. *ActiveX Designers,* reflection, and scripting/automation? Can some kind of generic business objects, capable of being configured into almost anything, be useful?

6) *Lack of data model flexibility.* Another fundamental flexibility problem of *business objects* concerns data. Most sizeable companies having been in business for some time will have multiple databases that hold similar data about employees, customers, accounts, etc., but with disparate record and field layout depending on the (legacy) application for which the database in question has been designed. Standardisation of such data models has proved very difficult also within a single company and will become much more so when company borders are crossed, although the efforts of various domain standardisation bodies may perhaps at long last begin to countervail the current babel of data models somewhat. How can business objects be made to adapt to disparate data models – possibly more than one at a time? Can some kind of a schema or data retrieval configuration mechanism be happily wedded to a user interface configuration mechanism?

7) *Ripple effects and lack of unity of multi-tiered organisation.* Because of "ripple effects", the problem of data model flexibility will be much exacerbated in a multi-tiered client/server solution such as that advocated by Sims and many others: Simply put, each new layer implies another point where adaptation must be done, thereby effectively defeating flexibility and reusability. Additionally, there will be a problem of conceptual unity, when a *business concept* is represented not by a single abstraction, but by a *view, model, focus, entity,* and *resource CBO* and one or many database records at that. This is evidently perceived in the Eeles/Sims and Herzum/Sims books and partly addressed through the concept of a *business component*, although in effect this concept provides little more than a unifying name for the disparate parts, papering over the underlying lack of unity. What really is needed instead of a complex multi-layer machinery is the semblance of an object-oriented database, where the *business objects* would be located in the database when inactive and transparently activated and cached in the client as needed without the business developer having to be concerned about how this happens. However, current database technology will not within the foreseeable future be replaced with object-oriented databases – the latter have not, so far at least, been very successful in the marketplace and are widely regarded as immature and niche-oriented. Can mainstream database access technology, such as *Microsoft's ADO (ActiveX Data Objects)* and *RDS (Remote Data Service)* be used to alleviate the multi-tier dilemma and provide a usable data access machinery without the need for extensive coding? Would it be possible to use, for example, *cabinet files* and an *Internet*-style downloading mechanism[844] to keep the executable business object code used in clients up to date with the latest versions of the code published on one or a few central servers?

8) *Lack of suitability for the Internet. Business objects* are executables, and executables are not generally considered suitable in an *Internet* context because of the security risks and portability problems they imply. How can *business objects* be combined with current web and virtual machine technology so as to eschew these problems?

9) *Class fragility.* If business objects are to be used as *components* they should also avoid the awkward problems usually referred to as "the fragile base class problem". Of the two main varieties of this problem-complex, *syntactic* and *semantic* fragility, *Newi*-style *business objects* are impervious to the former. Can they be modified so as to avoid the latter as well?[845]

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844 See below p. 547.

845 On p. 228 et seqq. this question as well as class fragility in general will be explored.

10) *No payment mechanisms*. According to Brad Cox, in order for *software components* markets to materialise infrastructural support for doing business (i.e. purchasing, renting, paying, etc.) with components will be needed.[846] How can *business objects* be made ready for business in this concrete sense?

I will come back to some of the above issues in the next chapter, in which I will outline the new agenda of realistic computing.

[846] See above p. 36.

1.5 *BODTF* – BUSINESS OBJECTS, *OMG* STYLE

All since its inception the *Business Object Management Special Interest Group (BOMSIG)* of the *Object Management Group (OMG)* – later renamed the *Business Object Domain Task Force (BODTF)* – has been a major driving force and focus of interest of the *business objects* movement.[847] For an extended period of time, this group was able to attract the interest of most luminaries of this field, and sanguine expectations were attached to its attempts to establish a foundation for *business objects.*[848] When in mid-1998 the proposal that eventually came out of the *BODTF* labours failed to gain the necessary acceptance within *OMG,* this was widely perceived as a major setback to the entire field and since the interest in *business objects* has receded markedly, at least judging from the coverage in the computer press and recently published books.[849]

1.5.1 A SHORT HISTORY OF THE *BOMSIG/BODTF* EFFORT

BOMSIG was formed in January 1994 at the instigation of Robert Shelton, president of *Open Engineering Inc.,* a consulting company specialising in the application of object-oriented methods to "business engineering".[850] Shelton was initially appointed chairman of the committee, but in 1995 he was succeeded in this position by Cory Casanave, founder and co-president of *Data Access Corporation,* a company probably best known for its 4GL tool *Dataflex*. During the first two years of operation, a draft for a *Business Application Architecture*[851]*,* later renamed a *Business Objects Reference Model*[852]*,* was put together as well as a short *BOMSIG* glossary of terms[853], and a *business object* "survey" was carried out.[854] Among the early achievements was also this influential working definition of the term *business object,* culled from the *BOMSIG* glossary:

> *A representation of a thing active in the business domain, including at least its business name and definition, attributes, behavior, relationships and constraints. A business object may represent, for example, a person, place or concept. The representation may be in a natural language, a modeling language, or a programming language.*

Taking their cue from Robert Shelton, the *BOMSIG* documents distinguished *business objects* from *technology objects* (sometimes referred to as *foundation objects* instead) and *application objects.*[855] *Technology objects* carry out various functions related to computer and software technology; they include *GUI* components and objects that implement *CORBA ORBs, CORBAservices, CORBAfacilities,* and operating system, database, and network services. *Application objects* are variously understood as complete applications (viewed as large-grained objects) or as objects specific to a certain application, possibly acting as "glue" between the *business objects,* which, in

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[847] There are currently two home pages of the *BODTF* effort at the OMG web site, http://www.omg.org/homepages/bodtf/index.htm and http://www.omg.org/homepages/bodtf. In addition, the archives of *BODTF* are available at http://cgi.omg.org/cgi-bin/doc?bom and ftp://ftp.omg.org/pub/docs/bom, although the directory listings can no longer be accessed directly by the public. The related *Business Objects Initiative (BOI)* has a home page of its own at http://www.omg.org/homepages/boi, as has the currently more active *Business Enterprise Integration DTF* at http://bei.omg.org. There were also several e-mail discussion lists associated with the *BODTF* initiative (once catalogued on the *BODTF* web page and archived under http://www.omg.org/archives). Most important amongst these e-mail lists were the *BOMSIG* list http://www.omg.org/archives/bomsig and the *BOI* list http://www.omg.org/archives/boi-wg. On the web page http://www.omg.org/techprocess/meetings/schedule/Business_Objects_RFP.html, the original *business objects RFP* and submissions, which will be our main concern here, were also available when this chapter was written – currently these are found at http://cgi.omg.org/techprocess/meetings/schedule/Business_Objects_RFP.html.

[848] Cf. e.g. [Beri97] p. 12 et seqq. and [Grif98] p. 89 et seqq.

[849] See above p. 109 et seqq.

[850] [OMG94a]. Cf. also p. 132 above.

[851] [OMG95b]

[852] [OMG95c]. The term *reference model* is used differently by different communities. Here it is understood more broadly than in some works on *software architecture,* such as [BCK98], which defines it (on p. 25) as "a standard decomposition of a known problem into parts that cooperatively solve the problem". Ibid., the mapping of a *reference model* onto software components is called a *reference architecture.*

[853] [OMG95e]

[854] [OMG94b]

[855] So e.g. [OMG95b] p. 9. Shelton's terminology is discussed above on p. 132.

contrast, will be common to multiple applications. Another important distinction of Shelton's influencing the early work of *BOMSIG* was that between *business entity objects,* which represent business "things", and *business process objects,* which represent business "processes", i.e. encapsulations of behaviour, in particular of long-lived processes such as workflows or long-lasting transactions. Additionally, users were supposed to interact with *business objects* through *presentations,* which could be part of an interactive application or be attached directly to the several *business objects.*[856]

Early in 1996, *BOMSIG* was re-organised as an *OMG* domain task force and was, hence, renamed the *Business Object Domain Task Force (BODTF).*[857] At that time, the business object facility/common business objects *RFP* was also issued[858], and in 1997 two additional *RFPs* were put together by *BODTF* on a workflow and a calendar facility, respectively, as well as an *RFI* for *Common Business Objects (CBOs).*[859] As the *business objects RFP* and process will be attended to at length below, the dramatic events surrounding it will be skipped over for now; suffice it to say that the final *CBOF (Combined Business Object Facility)* proposal that resulted from this endeavour was withdrawn in July 1998, as it became clear that it would not garner the voting support necessary for adoption as an *OMG* specification. In the aftermath of this debacle, Cory Casanave resigned as the *BODTF* chair, in which position he was succeeded by Fred Cummins from *EDS* and David Zenie from *Genesis Development Corporation.*

At about the same time, a *Business Object Initiative (BOI) Working Group* chaired by David Frankel from *Genesis Development Corporation,* Tom Rutt from *Lucent Technologies,* and Ed Seidewitz from *DHR Technologies* was also formed under the patronage of *BODTF.*[860] In March 1999, this group issued three new *RFPs* of much more humble goals than the original rather broad-brimmed *business objects RFP,* viz. for a *UML™ Profile for Enterprise Distributed Object Computing*[861]*, A UML™ Profile for CORBA*[862]*,* and *A Human-Usable Textual Notation for the UML™ Profile for EDOC*[863]. These three *RFP* processes were initially expected to be completed in 2000/2001, and proposals were indeed soon received for the two first ones[864], whereas the third *RFP* process has progressed at a much slower pace, presently still being in process.[865] The *UML™ Profile for CORBA™ Specification* is now a specification officially finalised by *OMG* and also the *UML Profile for Enterprise Distributed Object Computing Specification* has been adopted, although at the time of writing it has not been passed through the finalisation stage.[866] Simply put, a *UML profile* is an adaptation of the *UML* meta-model and modelling notation for a special purpose, taking advantage of the support for customisation built into *UML* through, inter alia, constructs such as *stereotypes, tagged values,* and *constraints.* The *EDOC (Enterprise Distributed Object Computing)* profile was, for example, intended to provide modelling support for distinct *business entity, process, rule,* and *event objects*[867] and for such "enterprise" features as transactions, security, persistence, and component packaging, whereas the *CORBA* profile was intended to facilitate the generation of *CORBA IDL* code automatically from specifications that make use of the *UML EDOC* profile and the textual notation was supposed to provide for a human-readable specification language that would mirror the modelling capabilities

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856 [OMG95c] p. 1 et seqq.

857 [OMG96f]

858 [OMG96b]

859 [OMG97v], [OMG97u], and [OMG97o].

860 Its goals are described in the roadmap [FSR98]. See also http://www.omg.org/homepages/boi.

861 [OMG99b]. Although *BOI* is subordinate to *BODTF,* its three *RFPs* were formally issued by the *OA&DTF (Object Analysis & Design Task Force)* of *OMG* rather than by *BODTF.*

862 [OMG99c]

863 [OMG99d]

864 More details are provided by the web pages http://cgi.omg.org/techprocess/meetings/schedule/UML_Profile_for_EDOC_RFP.html and http://cgi.omg.org/techprocess/meetings/schedule/UML_Profile_for_CORBA_RFP.html. A revised *UML™ Profile for CORBA* [DDGT+00] supported by all the original submitters was quickly worked out.

865 See http://cgi.omg.org/techprocess/meetings/schedule/UML_Textual_Notation_RFP.html and the technology snapshot web page http://www.omg.org/news/meetings/tc/Tech_Adoption/index.htm.

866 See [OMG02i-j]

867 Another *RFP* [OMG00] issued by the *OMG OA&DTF* also requests a *UML* profile for the modelling of *events,* although more specifically for the purpose of *enterprise application integration (EAI).*

of the *EDOC* profile closely. Since neither modelling nor the generation of *CORBA IDL* code is a major concern in this study, we will not delve further into these efforts.

As for the aforementioned workflow *RFP,* a workflow specification was adopted by *OMG* in November 1998,[868] of which version 1.2 is now available.[869] The work on *Common Business Objects* has resulted in an adopted specification of the *Task* and *Session CBOs*[870], which has gone through a revision process as well.[871] There is currently still one pending *RFP* originally issued by *BODTF* on an *Organizational Structure Facility* intended to "allow applications the ability to define, navigate, and inquire information defining a company's organizational structure".[872] None of these efforts will be further discussed here. Now, we will instead take a good look at the *Business Object RFP* and the different submissions provided in reply to it.

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868 [CCCD+98a-b]

869 [OMG02k]. At http://cgi.omg.org/techprocess/meetings/schedule/Workflow_RAI_RFP.html, some information about the related *Workflow Resource Assignment Interface RFP* process can be found.

870 [NIII98a-b]

871 See [OMG99e] and [MAG99], which also lists various other documents *(IDL* files etc.) that are part of the revision. The finalised version of the specification [OMG02l] was issued in April 2002.

872 See http://cgi.omg.org/techprocess/meetings/schedule/Organizational_Structure_RFP.html. Four initial submissions were received. Additionally, some initial work organised by *BODTF* has been done concerning both a *Document Repository Integration RFP* (see http://cgi.omg.org/techprocess/meetings/schedule/Doc._Repository_Integration_RFP.html) and a *Knowledge Management RFI (Request for Information;* see http://cgi.omg.org/techprocess/meetings/schedule/Knowledge_Mgmt._RFI.html).

1.5.2 THE *BOF/CBO* REQUEST FOR PROPOSAL

The *Request for Proposal (RFP)* setting the stage for the *OMG business object* effort was issued as the *Common Facilities RFP-4* in January 1996.[873] The submissions were initially due in September 1996, but the submission period was later extended into January 1997. The *RFP* was concerned with two rather different aspects of *business objects:*

- *Common Business Objects (CBOs)* – "Objects representing those business semantics that can be shown to be common across most businesses"[874]
- *Business Object Facility (BOF)* – "The infrastructure (application architecture, services, etc…) required to support business objects operating as cooperative application components in a distributed object environment"

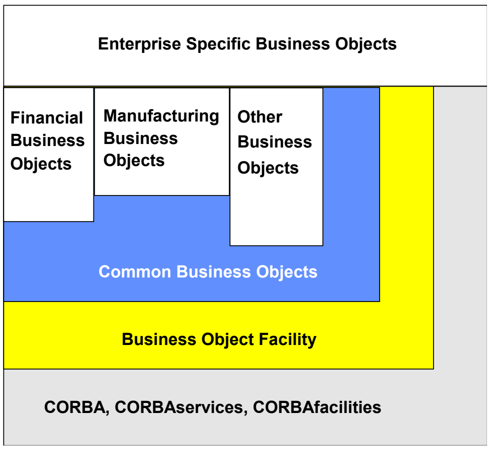

Figure 16. CBOs and the BOF in the OMG architecture. Courtesy Cory Casanave and BODTF.

This double intent did not make for clarity, and the *RFP* did not separate the requirements for each specification precisely. Most requirements seem to have been intended for the *BOF* specification, which, indeed, should be the more important of the two, but at times there will be doubts about what is the proper purview of a certain requirement.[875] It could be argued that the design of the *Business Object Facility* will be so influential upon the design of the *CBOs* that it should have been decided upon first.[876] The relationship between *CORBA,* the *BOF,* and the different categories of *business objects* are illustrated in *Figure 16*.

The *RFP* is organised in a rather formal manner, typical of *OMG RFP* documents, including large chunks of boilerplate text. The most interesting parts of it will be the introduction, where an overall vision of *business objects* is presented, and the fourth and particularly the fifth section, which specify the various mandatory and optional requirements that the submissions should attempt to meet.

1.5.2.1 Vision

Today's constantly changing business world with its need for flexibility and rapid adaptation is the background of the need for *business objects*. Rapid solution development and short cycle-times are necessary to meet the need for constant change.[877] Empowered users should be able to alter various aspects of the software they use in concert with their own needs and the frequent shifts taking place in the environment and business processes they are part of. The tools to bring about this will be "componentization, model-based

[873] [OMG96b]. When *OMG* performed a re-organisation of its committee structure, the *RFP* was transferred from the *Common Facilities Platform Task Force* of the *Platform Technology Committee* to the *Business Object Domain Task Force* of the *Domain Technology Committee.* Consequently it was renamed *Business Object RFP-1*.

[874] Id. op. p. 2.

[875] *Common Business Object (CBO)* is used as a synonym of *business object* – both in the analysis and the executable sense – in some passages, e.g. [OMG96b] p. 4. This confusing usage seems to originate from the press release [OMG95d], where *Common Business Objects* are touted as a *consistent "business" view* on top of the technology infrastructure of *OMG*.

[876] Cf. [EDS97] p. iii.

[877] [JEJ94] will be one important source of inspiration for these ideas. Cf. [Casa95] p. 14.

specifications, and end-user solution composition"[878], and *business objects* are believed to be those encapsulators of complexity that will do for software productivity what semiconductor components once did for hardware construction. As a consequence of standardisation, a marketplace for reusable *business objects* will form and make the removal of the "major hurdles" of development time, maintenance/enhancement costs, and programme complexity possible. Such is, at least, the vision of the *RFP* document.

Those remarkable *business objects*[879], what will they be like? Some fundamental features are mentioned in the introduction to the *RFP* – and many more details are given in the requirement specification. Just to name the main features, *business objects*:

- are a specialisation of the concept of an object for the business area
- are large-scale – i.e. business objects will not implement low-level technology concepts like integers, stacks or arrays
- model high-level, real-world, business concepts – "things active in the business domain"[880] – relevant to application domain developers and end-users
- map one-to-one to design/analysis concepts in order to minimise loss of semantic information between design, implementation, and deployment
- make ad-hoc, "plug and play" integration between objects from different suppliers possible, including unforeseen interactions
- are simple enough to make design and implementation viable for average developers who lack systems programming skills – technological complexities should be hidden by the *Business Object Facility,* which should provide an easy-to-use *infrastructure* and/or *framework* for business objects

Furthermore, the *RFP* stresses the importance of the *multi-tier* client/server model, where presentation, business logic, and persistence are strictly separated physically as well as logically. This is in contrast to the traditional two-tier architecture, which according to the *RFP* "does not scale to encompass the needs of the enterprise and change within the enterprise". The domain of business objects will be business logic, semantics, and concepts, and business objects should be kept isolated from presentation and storage technology as far as possible. Consequently, the *business object model* will be entirely liberated from presentation and storage considerations, and this liberty will make it – and not technology – "the driving force of the information system".[881]

In sum, the most important features promulgated in the *RFP* vision are:

- a close mapping between the real-world business concepts tracked down in *the business object model* during object analysis and modelling on the one side and the implementation and run-time constructs of software on the other
- *components* as the catalyst of a new era of rapid solution development and end-user empowerment

[878] [OMG96b] p. 3. The term *model-based specification* here probably is intended to indicate roughly the same thing as what is more often referred to as *model-based development,* i.e. the direct representation of business structures and functions in software models. Cf. [Tayl95a] p. 16 et seqq. and [Digr95] p. 158.

[879] The *RFP* attempts to make a distinction between *business objects* as modelling abstractions and *application components* as their implementation in concrete information systems. This distinction is not strictly upheld in the *RFP* and will not be adopted here. Cf. above p. 114.

[880] [OMG96b] p. 19. Cf. the *BOMSIG* definition given above.

[881] [OMG96b] p. 5.

- the isolation of *business objects* from presentation and storage considerations as a consequence of a three-tiered client/server architecture paradigm where business objects belong to, as it were, the "muddle in the middle"

Little is said about how components or business objects should interoperate and be glued together to bring about ad hoc-integration etc., but in some passages assembly of components into *applications* is suggested.[882] The choice of the ambiguous term *application component* to signify the run-time representation of a business object gives an impression that there was some beating about the bush going on here.[883] Nevertheless, the *RFP* seems to adopt a view of business objects as components *being part of* applications rather than *being* independent entities in their own right.[884] This would implicate a more traditional approach than Oliver Sims' and would make *business objects* come out quite close to *MTS/COM+* or (*Enterprise) JavaBeans* components. Such business objects would be streamlined for a life as middleware between *GUIs* and databases, but they would differ from ordinary *ActiveX/COM* and *JavaBeans* components by being devoid of any user interface.

1.5.2.2 Requirements

The requirement lists presented in the *RFP* are quite comprehensive although not painstakingly detailed. The requirements are classified into five groups:

- *general technical requirements,* i.e. the rules all *OMG* specifications will have to play by to conform with the *Object Management Architecture (OMA)*
- *general non-technical requirements,* a general requirement about "proof of concept"
- *requirements submissions must address,* mandatory requirements specific for this *RFP*
- *requirements submissions may address,* optional requirements specific for this RFP
- *technical criteria* are not requirements in the strict sense, but rather "technical issues" important to business objects

The different categories of requirements will now be examined in order.

1.5.2.3 General Technical Requirements

The *general technical requirements* dictate how adherence to the *OMA* architecture should be preserved so as to keep the *OMG* specifications consistent.[885] Among the more interesting regulations is the ordinance that interfaces should be expressed in *OMG IDL*. This requirement is not uncontroversial as far as components and business objects are concerned. Other important requirements prescribe that consistency with *COSS (Common Object Services Specifications)* should be striven for, that any extensions to existing *CORBA* specifications must be clearly identified, and – most importantly – that no implementation descriptions should be given in the submissions.

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[882] "The Object Management Group's central mission is to establish an architecture and set of specifications, based on commercially available object technology, to enable **distributed integrated applications.**" ([OMG96b] p. 2) "Finally, application components should be easy to build, use and assemble into functional applications by the typical applications developer." (id. op. p. 23). Additionally, there is an explicit requirement for "application integration".

[883] Cf. also [OMG96b] p. 23.

[884] According to the terminology we introduced in section 1.1 on p. 113 et seqq. above, the *RFP* usage of the term *business object* clearly encompasses the *business domain object, real-world object, analysis object,* and *middleware object* interpretations. *Business object* is not used in the sense of *framework-based object* or *executable object,* but the *ultimate component* idea appears to be at least implicitly present in many passages.

[885] See [OMG96b] p. 13 et seqq.

1.5.2.4 General Non-Technical Requirements

The point of the *general non-technical requirements* is that each submitter should provide a proof of concept statement, i.e. demonstrate that its proposal is technically viable by reference to an implementation.[886] A specification should not be adopted by *OMG,* unless there is a commercially available implementation of it from one of its members.

1.5.2.5 Requirements Submissions Must Address

Various mainly non-functional requirements, couched in terms not being overly specific, have been catalogued as mandatory.[887] The requirement list includes:

- *Interoperability* – business objects should interoperate regardless of *BOF* implementation, programming and human language, operating system etc.
- *Separation of technology* – business objects should be independent of technology and "issues such as model, process, persistence and interface" should be independent of each other.
- *Extensibility of business objects* – business objects should be extensible through mechanisms such as inheritance, delegation, or configuration.
- *Reusability* – to create an open market of business objects, business objects must be reusable.
- *Scalability*
- *Ease of development and deployment* – usability should be addressed from the perspective of the "business system developer and user".
- *Application integration* – it should be possible to integrate business objects into applications.
- *Security*

1.5.2.6 Requirements Submissions May Address

The requirements that are optional, but "nevertheless considered to be important"[888] include[889]:

- *How business objects implement the business model* – how the mapping between business concepts and business objects is done is of course an important concern.
- *Legacy applications* – business objects may be integrated with and even implemented by legacy applications.
- *Flexibility and longevity* – this requirement concerns the flexibility, maintainability, and longevity of implementations.
- *Generality and desktop integration* – business objects may be compatible and integrate with de facto standards such as *OLE* and *Windows* and, additionally, may be implemented by other infrastructures than *CORBA*.
- *Proof of commonality* – commonality among business domains is a requirement mainly geared towards *Common Business Objects*.
- *Specifications of business objects and metadata* – there may be a need to represent in a textual or executable form (as metadata) semantic information about business objects that could not

[886] See [OMG96b] p. 17.

[887] Such vagueness is, of course, not necessarily a drawback, as it will be apt to solicit a more variegated and hence probably more interesting motley of replies than a tightly knit web of requirements would be able to. See [OMG96b] p. 26 et seq.

[888] [OMG96b] p. 26

[889] [OMG96b] p. 28 et seqq.

be expressed in plain *OMG IDL*, e.g. "constraints, rules, roles, policies, relationships, states, attributes, visibility, dependencies, protocols, pre and post conditions, error conditions, warning conditions or events".[890]

- *Multilingual use*

1.5.2.7 Technical Criteria

The technical criteria are features that probably will be needed to build a business object infrastructure, but may also be rejected as unnecessary in a submission. Some of these criteria may be met by other *OMG* specifications, in which case an explanation is asked for of how these existing services are used. The criteria are[891]:

- *Change and event notification* – objects should be able to register with other objects for events and changes.
- *Active views* generalise the concept of database views and, consequently, simplify complex representations by excluding unneeded data and operations, perform alias and signature conversions, insulate applications from model changes, and actively keep themselves current with the underlying objects through some automatic link mechanism.
- *Transparent persistence* – business objects should be able to save their state and recover it on a later occasion.
- *Search mechanism* for locating objects
- *Backout* – a capability to return to an earlier state is needed for rollback handling in transaction, undo, etc. management.
- *Concurrency and serialization* support is needed in transaction handling in order to serialise concurrent transactions so that they will execute one after the other.
- *Nested transactions*
- *Referential integrity and garbage collection* refer to a mechanism for the detection of objects lacking valid references – in no way a simple task in a distributed environment – and the removal of such objects from memory.
- *Encapsulated attributes and relationships* will make it possible to define a standard protocol for accessing these features in order to conceal the implementation.
- *Constraints, rules, and policies* will need to be specified to assure integrity in concert with business rules.
- *Relationship management* – standard protocols for relationship management will be needed as well as automatic integrity-preserving mechanisms for the maintenance of two-way relations.
- *External name management* pertains to the handling of real-world names of business concepts, including synonyms.
- *Exception/fault resolution* includes mechanisms for error reporting, process restart, and handling of messages to non-existing objects.
- *Configuration management* deals with two features: upgrading running distributed systems without interruption and the capability of business objects to be configured and subclassed after installation.[892]

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[890] [OMG96b] p. 28

[891] [OMG96b] p. 29 et seqq.

[892] This seems to repeat the mandatory requirement for *extensibility of business objects* ([OMG96b] p. 26).

- *Composite object bounds* – objects being aggregated by an owning object should be versioned, stored, and transported together with their container objects.
- *External resource representation* is needed for I/O devices and the like.
- *User attributes and preferences* can be used to define defaults, warning levels, experience and proficiency levels on a per-user basis.
- *Textual representation* of business objects capable of being stored, moved, and edited and of handling circular and other complex structures
- *Executable object expressions* in a language independent of programming environments may be used "to express operations on objects in the form of objects" that may be passed between computing environments – this can be useful for rules, constraints, exceptions, iteration, event processing, etc.
- *Loose binding* of method and/or message data may be needed to bring about interoperability between binaries independently developed.
- *Instance specialization* is the ability to add methods and data attributes to object instances during run-time, temporarily or persistently.
- *Reflection,* i.e. "the ability of a system to analyze and report its state and activities and to alter its state and activities based on this analysis", could be useful for a plethora of tasks such as "exception resolution, automatic code generation, interactive query, machine learning, performance tuning and adaptation to particular users" as well as "support tools for analysis of system performance, debugging, design of tests and failure mode analysis" – such a facility should support switching a process from compiled execution to interpretation in order to support both good performance and reflection.
- *External interfaces* to e.g. user interfaces or desktop programmes should be consistent.

1.5.2.8 Some final remarks

The wealth of requirements given in the *RFP* may seem overwhelming, especially since many of them are quite demanding.[893] On the other hand*,* one may well ask what is not in the *RFP*. It turns out that the *RFP* is reticent on several of the more sticky points of component and business object design, such as:

- Is inheritance as an extension mechanism harmful when considering a marketplace for separately developed plug-and-play components (the black-box vs. white-box component controversy)?
- What payment and licensing mechanisms will be necessary to create a business object market?
- Should components be independently executable – as the *CBOs* of *Newi* – or should they only be capable of execution as parts of applications, as is the case with *ActiveX* components and *JavaBeans,* or should both types of execution be supported?
- How should business objects/components be glued together and be made interoperable? Among the candidate mechanisms are both explicit and implicit invocation models. The former group includes ordinary static operation calls – probably through a broker –, dynamic call mechanisms such as *Microsoft's Automation* and *CORBA DII (Dynamic Invocation Interface)*, and semantic and possibly other kinds of messaging, whereas the latter encompasses various variants of event-based interconnection styles, including request events, software buses, etc.
- How do business objects relate to component-based transaction handlers, such as *Microsoft's COM+/MTS* and *Sun's Enterprise JavaBeans?*

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[893] The requirement list may be compared to the list of supercomponent features given in [OHE96b] p. 36 et seq. (see footnote 507 on p. 116 above).

- For plug-and-play interoperability to be possible, a *binary* standard is widely held to be a pre-requisite, whereas the *CORBA* approach is non-binary and *IDL*-based. From a *CORBA* point of departure, how should plug-and-play interoperability be effected?
- What about scripting languages? These are widely used in existing component technologies such as *ActiveX* and *OpenDoc*.
- What is the rôle of business objects on the Internet and in intranets/extranets? How are they related to the ideas about an *object web?*
- What will be the relation of the upcoming business object facility to existing technologies such as *OLE/ActiveX, OpenDoc,* and *JavaBeans?*
- Should the programmer work at the *CORBA* level or should he be protected from the complexities of *CORBA* programming by some high-level varnish or abstraction layer?[894]
- What will be the relation of business objects to object databases? Should it be possible to store business objects in an *ODBMS?* Or are business objects really only a substitute for object databases?

Some of these issues have since been addressed by other *OMG* initiatives such as the *CORBA Component Model* and *Scripting Languages RFPs.*[895] Indeed, the breadth of the *BOF RFP* caused much work on alignment issues – examples of at the time upcoming or recently adopted *CORBA* specifications of relevance to the *BOF* include the *CORBA OOA&D Facility (UML* as well as *MOF* parts), the workflow *RFP* of *BODTF* itself, the aforementioned *CORBA Component Model,* the *Persistent State Service,* objects by value, etc.

1.5.3 THE SUBMISSIONS

The requirements set down in the *RFP* were indeed exigent and turned out to be open to very different interpretations as well.[896] Additionally, the alarums and excursions on the component and the *CORBA* scenes during the reply period were breathtaking – the come-and-go of *OpenDoc,* the sudden rise of *JavaBeans* and then *Enterprise JavaBeans,* the issuance of an *RFP* for a *CORBA* component specification, and the adoption of *UML* and the *Meta-Object Facility* all made a large and lasting impact on the *business object* effort.

The initial responses to the *Business Object RFP-1* were – after a number of postponements – due in January 1997. Five different proposals were submitted in reply to the *Business Object Facility* part of the *RFP,* whereas three proposals concerning *Common Business Objects* were entered. The former group comprised submissions from *EDS*[897]*, SSA*[898]*,* a *Joint Business Object Facility (JBOF)* from *Data Access, SEMATECH, Prism,* and *IONA*[899]*,* another joint *BOF* from *IBM* and *Oracle*[900]*,* and yet another from *Genesis* and *Visigenic*[901]. The *Common Business Objects* submissions encompassed replies from *IBM*[902]*, TRC (The Technical Resource Connection)*[903]*,*

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894 [ES98] p. 162 et seqq. provides a plea for such a separation layer.

895 [OMG97f] and [OMG97e]

896 [Seid98b] points out the dichotomy between the "traditional" technically oriented *OMG* culture of distributed objects and the "newer" *OMG* culture of objects as analysis and design constructs. This dichotomy was present also in the business objects *RFP* as well as among the submitters and partly accounts for the widely different proposals.

897 [EDS97]

898 [SSA97a]

899 [DSPI97]. Various companion documents exist: [Data97b] is a "guide" to the *JBOF* proposal, [ODMG97] contains a description of *ODL* and *OQL,* the *ODMG* data definition and query language, which were incorporated by reference in the *JBOF* submission ([DSPI97] p. 14), and [Data97c] sets out to evaluate all the submissions made to the *RFP*.

900 [IO97a]. [IO97b] is a companion position statement.

901 [GV97]

902 [IBM97a]

903 [TRC97]. This submission does not contain any specifications of *CBOs,* but is mainly concerned with ontology-based domain modelling as a pre-analysis activity, the purpose of which is to gather the understanding of a domain and its *ontology* (i.e. vocabulary) in order to identify and give shape to reusable domain business objects. It is argued that "a major reason for the apparent failure of OO to

and from the *NIIIP (National Industrial Information Infrastructure Protocols) Consortium*[904]. Many of the proposals were in a rather crude, unfinished state when submitted and called for extensive revision, and the revision period consequently came to be fairly extended in time.

The revised submissions were finally exacted in November 1997. As for the *CBOs, IBM* and *NIIIP* linked their non-overlapping, but not very comprehensive[905] proposals together into a joint submission.[906] Later, the *IBM* contributions were removed from the proposal again[907], whereas a substantially revised version of the specification of the *Task* and *Session CBOs* originally submitted by *NIIIP* was adopted by *OMG* in November 1998.[908] This specification was revised again in 1999, whereupon followed a 2.0 release.[909] In 1997, a separate *Common Business Object RFI*[910] had also been issued, and a number of replies was then received, although no specifications came out of this initiative. In any case, we will not be much concerned with *Common Business Objects* here.

The *BOF* submissions went through various mergers during the revision process, and in November only three proposals remained: the *SSA* submission[911], to which only slight changes had been made since its first appearance, a joint *BOF* from *IBM, Oracle,* and *Visigenic*[912], which was a substantially revised version of the original *IBM/Oracle* submission, and the *Combined Business Object Facility (CBOF)* supported by *Data Access Technologies, EDS, NIIIP, SEMATECH, Genesis, Prism,* and *IONA*[913], essentially being a combination of the *JBOF* and *EDS* submission. These three remaining proposals were very disparate.

The *SSA* submission was a re-embodiment of *Oliver Sims'* vision of *Cooperative Business Objects* on a *CORBA* foundation.[914] The pith and marrow of the *IBM/Oracle/Visigenic* proposal was a number of *IDL*-based frameworks[915], whereas the most salient features of the *CBOF* proposal were the specification language

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deliver on reuse is insufficient attention to the issue of domain understanding" and that *OO* methods are ad hoc, too technology-oriented, and by "their emphasis on "passive" fine-grain objects" tend to produce "mutated/contorted models of reality" (p. 9). It is contended that *Common Business Objects* ought to be interpreted as "core meta-concepts" or "meta-business concepts" such as ***agent, object, script, event, process, procedure, task/action, time, space, relationship, role/responsibility, resource, rule interaction protocol,*** or ***organisation unit*** rather than as objects common to many domains such as *Customer, Address, Company,* etc. (p. 15 et seq.). In addition, the passive objects of classical object-orientation need to be supplemented by ***active objects*** or ***agents*** and the possibility of an agent-based *BOF* should be considered. Although the *TRC* submission is unique in its emphasis on the *AI* concepts of ***ontologies*** and ***agents*** and in its espousal of *AI* languages like *Ontolingua* and *KIF (Knowledge Interchange Format)* as tools for ontological domain modelling, it shares the preoccupation with meta-modelling with both the *JBOF* and the *Genesis/Visigenic* proposals. Likewise, agents have a great deal in common with the *XOs* of the *SSA* submission, although these are indeed *reactive* rather than *active*.

[904] [NIII97]

[905] The difficulties in finding the "right" *CBOs* are well made out in [TRC97] p. 13. Three possible approaches to the task are outlined: a pure top-down analysis, where a set of domains are selected and the *CBOs* common to them extracted, a bottom-up variant, starting with a comparison of commercially available libraries in order to find the common elements, and a combination of the top-down and bottom-up approach, having the best prospects of success.

[906] [IN97] and the final version [IN98a]. The *IBM* part of the submission comprised definitions – descending from *IBM's San Francisco* project – of *CBO* interfaces for decimal numbers, descriptive add-on information, addresses, time, and "involved parties". The *IBM CBOs* were originally closely aligned with *IBM's BOF* proposal; the objects prefixed with a *D* are, for example, *dependent objects* in the sense given by [IOV97] p. 27 et seqq., and had to be aggregated by an outer object. *NIIIP* is a consortium formed in order to promote the organisation of *Virtual Enterprises (VEs),* and the *NIIIP CBOs* were related to this aim. They included *AbstractParty, AbstractPerson, Group, User, Role, Credential, Workspace, Task, AbstractResourceAdapter, SessionManager,* and *SessionObject*.

[907] See [OMG98h].

[908] [NIII98a-b]. This contained definitions of the following *CBOs* (enclosed in a *SessionModule): AbstractPerson, User, Message, Desktop, Workspace, Task, Containment, AbstractResource,* and *Usage*.

[909] See [OMG99e] and [MAG99], which also lists the various supplementary *IDL* files and other documents that are part of the revision.

[910] [OMG97o]

[911] [SSA97b]

[912] [IOV97]

[913] [DENS+97a], [DENS+97b], and [EDIG+97].

[914] I have chosen to deal with the *SSA* submission in the same context as Sims' vision is discussed. See above p. 165.

[915] The *IBM/Oracle/Visigenic* submission, which was based on work done during the development of the *SanFrancisco Java* frameworks, contains specifications for two frameworks, the *Manageable Object Framework (MOFw)* and the *Business Object Framework (BOFw)*. The former supports independent *manageable objects,* which may aggregate *dependent* objects and themselves be contained in *homes,* a kind of collections

CDL (Component Definition Language) and the *Business Object Architecture (BOA),* a meta-model concerned with constructs – called *BOA components* – intended for the representation of business semantics in *business object models*. Additionally, the *EDS* interoperability framework had been appended to the *CBOF* proposal, providing, as it were, some infrastructural underpinnings for the lofty eidola of the *BOA* meta-model.

The very dissimilar nature of the *BOF* submissions has been well characterised in the *SSA CORBA Components* submission[916], where these four areas of coverage (besides *CBO* definitions) are identified:

- *meta-model* appropriate for business systems *(CBOF BOA)*
- *specification language* geared towards business domain components *(CBOF CDL)*
- *interoperability specifications* cast as *CORBA*-based frameworks *(CBOF/EDS* interoperability specification, *IBM/Oracle/Visigenic* proposal, *SSA BOF Services)*
- *infrastructure (virtual machine)* for extensible plug-and-play components/business objects *(SSA,* partially also *IBM/Oracle/Visigenic)*

Apparently, the common denominator of the three proposals was some kind of interoperability framework. In the discussions within *BODTF,* a distinction was repeatedly made between *interoperability* and *portability*. *Interoperability* is about providing interfaces that will make components interoperate, even across *BOF* boundaries, but will not make it possible to install and use – "plug and play" – a component developed for one *BOF* on another. For this to be possible *portability* is needed, which may occur either at the *source code* or at the *binary* level. In actuality, the differentiation between interoperability and portability features is difficult. The functionality of all the interoperability frameworks submitted includes some, more or less refined, support of:

- naming and identification
- life cycle operations
- persistence through externalisation/internalisation (not *CBOF)*
- transactions
- events, interest registrations, and notifications
- relationships of different kinds (including dependent objects)
- collections

The above items correspond to various *CORBAservices.*[917] All submissions took advantage of the relevant *CORBAservices* in one way or other, but the strategy of employment differed: The *SSA* submission completely hid the underlying *CORBA* infrastructure away from the business object developer, whereas the other two proposals inherited from and extended existing *CORBA* interfaces. The latter approach may conform better with the *IDL* temper of *CORBA,* but does not make for non-*CORBA* implementations and, at that, tends to exacerbate the complexities of *CORBA* programming rather than abate them; and indeed, reduction of complexity should be a major design goal in order to make not only technology specialists, but also the business-oriented breed of programmers proficient and comfortable with the *BOF.*

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possibly having mappings to database storage. *MOFw* also extends the *CORBA* transaction, concurrency, and externalisation services in various ways.

The *BOFw* framework, being based on *MOFw,* adds support for persistent, transaction-aware *entity* objects capable of exchanging *notifications* and accommodating new *dynamic properties* at run-time. There are also two important interfaces for the representation of "business tasks", *Command* and *ApplicationControlObject*. *Command* supports simple (one-shot) transactions and can be used to make business objects interoperate without tight coupling, whereas the *ApplicationControlObject* interface is intended to manage conversational tasks composed of many operations. By the way, the *Command* interface is one example of how deeply this submission has been influenced by the *design pattern* movement; several others exist as well. A suite of collection classes supplements the other interfaces.

[916] [SSA97c] p. 1. Cf. also [ES98] p. 159 et seqq. and [Data97c] p. 4 where the original submissions are contrasted diagrammatically. Here is made the important distinction between "support frameworks" and "services", where the former are extended by users through inheritance and operate by calling user-supplied code in accordance with the *Hollywood principle* ("don't call us, we call you"), whereas the latter are implemented by objects, the methods of which are called by users just like ordinary *API* functions.

[917] None of the submissions deals explicitly with security issues, although lip service is regularly paid to the *CORBA* security service.

The outcome of the evaluation of the revised submissions made within *BODTF* was a recommendation of the *CBOF BOA* as a reference meta-model and the *CBOF/EDS Interoperability Specification* as a reference interoperability specification.[918] It was also concluded that a *portability framework,* addressing source code and binary portability issues as well as "deployment packaging constructs", might be a candidate for a new *RFP* and that the *SSA* and *IBM* submissions would be good starting points for such a portability framework. The *CBOF* team was instructed to address various issues in their specifications.

The final *CBOF* proposal was made public on January 19, 1998 and featured a large number of modifications, including also a change of the name *BOA* into *BOCA (Business Object Component Architecture),* to which was attached the revision number 1.1.[919] Additionally, the *Interoperability Specification,* having assimilated some features from the *IBM* proposal as well, was now supported also by *IBM, Oracle, Visigenic,* and *SSA,* whereas the *BOCA/CDL* specification was not. Thus, the adoption of the *OMG business object* specification, crowning more than four years' labours, at long last seemed to be within reach. The events during the spring and summer of 1998 would, however, prove otherwise.

There was considerable disagreement about the *CBOF* proposal within *BODTF* and *OMG* already when it was nominated a candidate for adoption, and the doubts gradually grew stronger, as time went on and a variety of issues were raised, both by *BODTF* insiders and outsiders. Firstly, there was much debate on "boundary issues" concerning possible overlaps or clashes – both of a technical and a strategic nature – with various other technologies and specifications. Whereas the *BOCA* metamodel seemed to compete with the *UML Meta-Object Facility (MOF), CDL* seemed like a potential competitor to both *IDL* and *UML,* depending on whether it was construed as a kind of super-*IDL* or as a specification language. Likewise, it was suggested that it would be a better idea to enhance the *CORBAservices* directly rather than to devise a competing *Interoperability Specification* geared towards *business objects* only. Concerns about mismatches between *BOCA/CDL* and *UML/MOF* had already caused considerable work to be done on their alignment[920], and although some of the results had been integrated into the *BOCA 1.1* specification, the concerns largely remained. Additionally, many critics quailed at the possible adversary or internecine effects of the *Interoperability Specification* on *Enterprise JavaBeans,* various *CORBAservices,* and the upcoming *CORBA Components* specification.[921] Secondly, the quality of the *CBOF* proposals and in particular of the *Interoperability Specification,* whose attachment to *BOCA/CDL* also appeared rather adventitious, seemed debatable. For example, the approach to transaction handling in this document was questioned[922] and the *IDL* declarations that accompanied it turned out to be flawed[923]. New versions of the *Interoperability Specification* were fleetingly produced[924], and at an *OMG* meeting in Manchester a *BOCA RTF (Revision Task Force)* was chartered, which was to work out a *Revision 1.2* of the *BOCA* document.[925] At the same meeting, the *BOCA*[926]*, Interoperability Specification*[927]*,* and *CBO*[928] proposals were recommended for adoption through three votes – ominously held on April 1st.[929]

In spite of these recommendations, a little later the proposals were disowned by leading *OMG* members that previously had backed them up, at least officially: *IBM, Oracle,* and *Inprise* (i.e. the fused *Borland/Visigenic)* withdrew their support (as co-submitters) for the *Interoperability Specification,* and so did *IONA* with reference

918 See [OMG98j].

919 [DENS+98a], [DENS+98b], and [EDIG+98a].

920 See, for example, [Digr97b-c], [Data97e], [Seid98a], [CE98], [OMG98d], and [Digr98a].

921 Cf. [OMG97t].

922 [Cobb98a]

923 [Burt98]

924 [EDIG+98b-d] and [EDGN+98a-b].

925 The 1.2 revision [DENS+98c] and a supplementary "abstraction framework" [OMGB98] were delivered at the beginning of July. Cf. also http://www.omg.org/archives/boca-rtf. Additionally, two errata lists [OMG98e-f] for the 1.1 revision were put together.

926 [DENS+98a] and the errata list [OMG98f].

927 [EDIG+98c] and the errata list [Cumm98].

928 [IN98b] and the errata [IBM98d].

929 [OMG98g]

both to the *Interoperability Specification* and to *BOCA.* Another *BODTF* meeting in June in Orlando postponed the adoption process for the *Interoperability Specification* – so as to allow it to become better aligned with the *CORBA Components* proposal – and removed the *IBM* part of the *CBO* proposal.[930] Nonetheless, the fax voting process concerning the *BOCA* proposal started, but as it became evident that *BOCA* would not gain the support necessary for adoption, the submitters chose to withdraw their proposal in order to be able to re-submit it after further revision.[931] Except for the *NIIIP CBOs,* which somehow managed to pass the adoption process and obtained *OMG's* hallmark as an adopted specification in November 1998, the *BODTF RFP-1* was officially terminated on July 30, 1998 at a meeting in Helsingfors.[932]

Since what the *BODTF RFP-1* primarily asked for was a design for a *Business Object Facility infrastructure,* it might appear somewhat odd that a lengthy response, revision and evaluation process should eventuate in a proposal for a specification language and a meta-model, even though supplemented by an interoperability specification. Although there was a non-mandatory requirement for the "specification of business objects and metadata" in the *RFP*[933]*,* such a feature was nowise the focal point of the document.

Probably, the outcome, at least partly, reflected the then current bewilderment that ensued from the swift shifts in the technology preferences of the *CORBA* backers-up, as well as the apprehensions about the future fate and itinerary of *CORBA* instilled by, for instance, the ascent of various *Java* technologies such as *RMI, JavaBeans,* and *Enterprise JavaBeans.* A specification language, relieved of any technology considerations, should not run the risk of being rendered outdated before long by the rapid technology changes and should indeed be something quite useful when working on domain interface definitions, the cynosure not only of *BODTF,* but also of the *SEMATECH* and *NIIIP* consortia backing up the proposal.

Doubtless, another factor that contributed to the outcome was the formidability of the requirement list presented in the *RFP* – to transform these precepts into working technology would have been a major undertaking, for which the *OMG* process may not be a very adequate framework. The *SSA* submission, which was the only one that really did address the purport of the *RFP,* was probably doomed by the relative insignificance of the companies supporting it, its lack of congeniality with the *CORBA* style, its exotic design elements – such as semantic messaging and independently executable objects – and by the unwonted interpretation of the tenets of object-orientation it propounds, challenging widely cherished beliefs about e.g. the value of strongly typed interfaces. The *SSA* submission has been expatiated upon above[934] and the final *CBOF* submission will be examined below; only occasional attention will be given to the other submissions.

1.5.4 THE *COMBINED BUSINESS OBJECT FACILITY*

The *CBOF (Combined Business Object Facility)* submission was remarkable in many ways. Firstly, the revised tripartite *CBOF*[935] proposal was remarkable for its sheer size, widely surpassing that of the competing proposals – even if these were added together. At that, the diligence of the *CBOF* group gave birth to several

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930 [OMG98h]

931 A revised *BOCA* proposal was submitted by *Data Access* and *EDS* in response to the *BOI UML™ Profile for Enterprise Distributed Object Computing RFP*. See [DE99].

932 [OMG98i]

933 [OMG96b] p. 28

934 See p. 165 et seqq.

935 The original *JBOF* submission [DSPI97] was revised into the *CBOF* 1.0 submission [DENS+97a], which was accompanied by an "encyclopaedia" [DENS+97b] and the specification of an "interoperability framework" [EDIG+97], which owed more to the original *EDS* submission [EDS97] than to *JBOF.* The final 1.1 version encompassed revisions of these documents, [DENS+98a], [DENS+98b], and [EDIG+98a]. A *Rational Rose .MDL* file (OMG document no. bom/98-01-09) containing *UML* diagrams of the *BOCA* meta-model was also part of the 1.1 revision. [OMG98f] is an errata list of the *BOCA 1.1* document. The *BOCA 1.2 Revision* [DENS+98c] and its supplementary "abstraction framework" [OMGB98] arrived just before the *BOCA* submission was retracted in the summer of 1998; the *UML EDOC profile* submission [DE99] provides the latest variant of *BOCA*. We will here focus mainly on the "final" *BOCA 1.1* proposal [DENS+98a] and the associated version [EDIG+98a] of the *Interoperability Specification.*

companion proposals[936], guides[937], evaluations[938], etc. Additionally, there has also been some coverage of the technologies involved in the popular computer press[939], at developer[940] and research[941] conferences, and in book form[942], authored both by people associated with the *CBOF* effort and outsiders.

Secondly, the *CBOF* submission was remarkable for the number of ideas and influences that had been imbibed and integrated by it. In the original *JBOF* document, it was remarked that although the two greatest influences on it were *CORBA* and object-oriented modelling, it was also "very much influenced by DBMS systems, object-oriented DBMSes, CASE tools, computer languages (3GL and 4GL), and rule-based systems".[943] A plethora of advanced or novel object-oriented notions, such as roles, inheritance rules (co-variance/contravariance), template types, contracts (pre-and post-conditions, invariants), reflection and meta-objects, and various *ODMG-93* features, including support for *ODMG-93 IDL* and for *OQL* queries[944], were incorporated into the *JBOF/CBOF* edifice at some point in time, although some were let go of again.[945] Although there is a risk that such eclecticism, itself a sequel of a striving for semantic richness, may degenerate into sheer featuriritis, the dire consequences of which will include bloat, obscurity, complexity, overload, and the lack of unified underpinnings and vision, counter-measures against such corruption were taken, and in due course the submission moved towards an increasingly fastidious and synthesised selection of undergirding concepts.

Thirdly, the *CBOF* submission was remarkable for the fundamental ways it had changed since its original incarnation as *JBOF*. Many of its designs and ideas had been reshaped in crucial respects, whereas other elements had been jettisoned altogether, such as the original *Business Object Framework*. At the same time, new notions, influences, and design elements had been appropriated, most important of which will be the *EDS* interoperability framework. One major generator of change was the work on alignment with the *Meta-Object Facility (MOF),* adopted by *OMG* in November 1997, which influenced the submission deeply; another important alignment effort concerned the *Unified Modeling Language, UML,* to which the *MOF* is an adjunct. The revised submission, released in November 1997, still was far from shipshape and Bristol fashion, but rather had the appearance of "work in progress". The final January 1.1 revision seemed a little more settled, although many inconsistencies and unfinished items still loomed up throughout the *CBOF* documents.[946]

The main elements of the *CBOF* submissions were:

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936 [Data97a] is a proposal for the *Meta-Object Facility (MOF)* and [Data97d] is another proposal submitted in reply to the three related *OMG RFPs* about a *CORBA* component model, a *CORBA* scripting language, and *CORBA* support for multiple interfaces and composition.

937 [Data97b] is a guide to the original *JBOF* submission.

938 [Data97c] evaluates the original submissions from a *JBOF* point of view.

939 See, for example, in [GF98], [GO98], [GA98], and [Digr98b]. Cf. also [GM98].

940 [Digr99]

941 See [EE98c] and [Suth99]. Cf. also [EEOZ98].

942 [SC98] p. 99 et seqq.

943 [DSPI97] p. 4.

944 The interesting attempts at integration with *ODMG-93* in [DSPI97] disappeared altogether from the revised submissions [DENS+97a] and [DENS+98a]. As *business objects* largely serve as an *ersatz* for a true object-oriented database, the integration of *business objects* with *ODBMS* technology would have the potential to remove much of the *impedance mismatch* that is inherent in today's client/server systems as a consequence of the necessary transformations of objects into relational data and vice versa.

945 As it appears, the *Eiffel* language and the ideas of Bertrand Meyer were – directly or indirectly – quite influential, particularly on the initial *JBOF* submission. Pet ideas of Meyer's also present in *JBOF* include the importance granted to specifications, the *design by contract* style – including *invariants* and *pre-* and *post-conditions* –, and the notion of different inheritance policies such as *covariance/contravariance*. Cf. e.g. [HHG90], [Meye92], and [Meye97]. The significance imparted to *roles* in the *CBOF* submission is in accord with ideas disseminated by e.g. [RWL96] and [KR94]. Other important background matter is provided by the *OOPSLA* '95 *Business Object Design and Implementation* workshop contributions by Cory Casanave [Casa95] and Tom Digre [Digr95], both co-authors of the *JBOF* and *CBOF* submissions and very influential in the work on the *RFP* as well. The *RFP* was actually authored by Casanave in his capacity as chairman of *BODTF*.

946 Just to give one example, *BOCA* is strangely renamed *ECA* in several passages on p. 81 et seqq.

- The *Business Object Component Architecture (BOCA)*[947], a *meta-model* intended to facilitate the specification of business object systems by providing a set of constructs and types (referred to as *BOCA components)* appropriate for a business-oriented component architecture
- The *CDL (Component Definition Language)* specification language, a textual representation of the *BOCA* meta-model and a tool for the definition of business object interfaces
- The *Business Object Interoperability Framework* or *Interoperability Specification*, which defines various *CORBA*-based support interfaces

Central to the *CBOF* proposal was the popular notion that the *contractual* interdependencies between objects should be clearly spelt out.[948] The very gist of *CBOF* was the *CDL* specification language, which was an attempt to enhance *CORBA IDL* by providing a major increase in the amount of detail that may be contractually exposed through the interface of an object.[949] Notably, *CDL* was supposed to be put to use in the definition of domain-specific *business object* interfaces, which is the overriding responsibility of the *BODTF* sibling *DTF (Domain Task Force)* committees.

Another important design goal appears to have been the improvement of the semantic tooling used during domain modelling and analysis so as to reduce the *semantic gap* between real world domains and the artefacts of *business object* modelling[950], although the cost for this might be an increase of another *semantic gap,* to wit that between those same modelling artefacts and their representation in programme code. Here and elsewhere, the vantage point of the *CBOF* proposal was the object-oriented analyst's rather than that of the programmer or technologist.[951]

1.5.4.1 The Business Object Component Architecture

The *Business Object Component Architecture (BOCA)* provides a *meta-model* as a foundation of the *CBOF Business Object Facility*. Meta-model architectures may contain any number of meta-levels, but a four-layered design has gained widespread popularity[952]:

- A *meta-meta model* is "a model that defines the language for expressing a metamodel"[953]. For example, the *OMG Meta-Object Facility* defines such a *meta-meta model.* Concepts defined in a *meta-meta model* may include terms such as *metaclass, metaoperation, metafeature* etc.

- A *meta-model* is an instance of *meta-meta model* and "a model that defines the language for expressing a model"[954], usually describing the language constructs and types narratively

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[947] In [DENS+97a] and [DENS+97b], *BOCA* was called *BOA (Business Object Architecture)*. This was changed to *BOCA* in the final revision ([DENS+98a] and [DENS+98b]) in order to avoid confusion with the *CORBA Basic Object Adapter (BOA)*. Cf. http://www.omg.org/archives/bomsig/msg00695.html

[948] See e.g. [DENS+98a] p. 13, p. 19, and p. 172.

[949] The increase in exposure of semantic detail also implies an increase in *surface area*. Contractual specification really runs contrary to the strivings to decrease surface area e.g. by using semantic data objects as in *Newi* and in the *SSA* submission.

[950] Cf. [DENS+98a] p. 175.

[951] The *CBOF* proposal differs from the *SSA* and *IBM/Oracle/Visigenic* submissions by not being based on implementation experiences as regards the conceptual model it propounds (cf. [DENS+98a] p. 197), although the interoperability specification [EDIG+98a] p. 13 et seqq. contains some suggestions on implementation issues.

In programming languages supported by *CORBA IDL*, many of the proposed *BOCA/CDL* concepts, such as *roles, pre-* and *post-conditions,* transactional *invariants, processes,* and *states,* can only be given rather unwieldy code interpretations and will add substantially to the programmer's chores rather than subtracting from them, whereas others – e.g. *during, implicit events,* and non-transactional *invariants* – may be so cumbersome that they will not be possible to implement in any reasonable way at all. On the other hand, it could be argued that the *CBOF* proposal should not be faulted for disregarding implementation matters, but that the difficulty to transform its meta-model into implementation constructs just mirrors the inadequacy of current programming languages for a newfangled, not yet quite well understood style of programming, which calls for the construction of a new generation of programming languages more explicitly geared towards business object development.

[952] [CIIO+97a] p. 3-2

[953] [CIIO+97b] p. C-9

and/or diagrammatically. *OMG* already has two different meta-models in its repertory besides *BOCA*, viz. the *CORBA* core meta-model, mirroring the *CORBA IDL* language and the *CORBA* interface repository[955], and the *UML (Unified Modeling Language)* meta-model of the *OA&D (Object-Oriented Analysis and Design) Facility*. Typical concepts defined by a *meta-model* include *class, feature, attribute, operation,* and so on.

- A *model* is an instance of a *meta-model* and a "semantically closed abstraction of a system"[956], defining, as it were, a language for a certain domain. An *object model* constructed during an *OA&D* effort is one example of a model. The concepts defined depend on the domain modelled and may include terms like *Customer, Invoice, Car,* etc.

- *User objects/user data* together form an instance of a *model* containing concrete items of information such as <Pegasus Computer Ltd.>, <invoice no. 47055>, or <Daimler Double Six with registration no. GXZ 866>.

In contrast to the *UML* meta-model, the *BOCA* meta-model is a proper superset of the *CORBA* core meta-model, and the modelling language reflecting the *BOCA* meta-model, *CDL,* is, in turn, a proper superset of *CORBA IDL.*[957] Consequently, the *BOCA* meta-model is what in *OMG* parlance is called a *profile,* i.e. an extension, of the *OMG Object Management Architecture (OMA)* core object model.[958]

The *BOCA* architecture – as well as its documentation – is rich and complex, and, hence, it will only be possible to give a short inkling about it here, supplemented by a number of examples in *CDL*. The *BOCA* constructs for defining *business objects* are referred to as *BOCA components,* as said before.[959] *BOCA components* are used to define new *types* that may contain any mixture of *features*. Types and features may be prefixed by *type parameters* that modify the type or feature in one way or other. For instance, an attribute may be prefixed by a *[readonly]* parameter indicating that it might not be changed. The available *features* fall into six distinct categories:

- attributes
- relationships
- state sets
- signals
- operations
- apply statements

Attributes, relationships, and state sets[960] are referred to as *structural features,* whereas signals, operations, and apply statements are called *behavioural features*. The characteristics of the different kinds of features will be explained below and illustrated with snippets of *CDL* code.

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[954] ibid.

[955] [SS95] p. 45 et seqq. The *OMG OMA (Object Management Architecture)* guide [SS95] p. 51 states that the *CORBA* core object model is not a *meta model,* interpreting *meta model* as a "model for describing or deriving other object models". In our terminology, the core object model is, however, a *meta-model,* and what is referred to as a *meta model* in [SS95] will be a *meta-meta model!*

[956] [CIIO+97b] p. C-9

[957] [DENS+98a] p. 44.

[958] [SS95] p. 47. In version 1.0 of *CBOF,* it was stated that the *BOA* meta-model was a derivation of the *CORBA Interface Repository,* but these statements have been altered in version 1.1. Cf. [DENS+97a] p. 77 and [DENS+98a] p. 84.

[959] In the original *JBOF* document [DSPI97], the term *semantic component* was used instead. In [DENS+98a], *component* and *BOCA component* are usually synonymous. Cf. [DENS+98a] p. 21.

[960] At times, the documentation does not include states among the structural features. See e.g. [DENS+98a] p. 24.

Attributes “contain "dependent" types, objects, interfaces or primitive values that are not independent business objects”.[961] From the outside, they are usually accessed through access methods. The *CDL* syntax for attributes is illustrated below:

```
entity Person {
   attribute string name;
   attribute short age;
   attribute Set<Address> addresses; // collection
};
```

Relationships of different kinds may be specified. Every relationship has a name, and it may optionally have a kind (e.g. *RoleOf, Aggregates,* or *Composes)* and a multiplicity as well. The name of the inverse relationship must be added, in case the relation is two-way:

```
relationship <name> [kind] [multiplicity] <type> [inverse <name_of_inverse>]
```

A number of *standard relationships* is defined, including the aforementioned *RoleOf, Aggregates* or *Composes.*[962] For each type of relationship appropriate “cascade rules” for the *copy, move,* and *delete* operations are defined as well as permissible multiplicity options, inverse types, etc.

```
entity Customer {
   relationship delegates RoleOf Person inverse delegated_by;
   relationship places Many 1..* Order inverse ordered_by;
};
```

State sets encompassing any number of *states* may be defined for a component. One state must always be true, and no more than one state may be true at any time.[963] A *during block* contains definitions (which may include nested states) that only may be referenced while the *during* condition – frequently a state expression, although any Boolean expression may be used – is true.[964]

```
entity Restaturant {
   state_set status (open, closed);
   during (status==open) openStatus {
      state_set kitchenStatus (cooking, noCooking);
      attribute noOfFreeTables;
   };
};
```

Signals are events explicitly declared inside a component.[965] In most cases explicit declaration of events will, however, not be necessary, since *CBOF* specifies an event model, where every feature change or operation call/completion/failure is a *candidate event producer* that may cause event notifications to be sent automatically to any objects that have registered interest in a particular *implicit event.*[966] Interest registration is *declarative* and is made as a *dependency rule,* a special kind of *appliance,* in the *client* object. *Triggers* inside such a *de-*

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[961] [DENS+98a] p. 37

[962] [DENS+98a] p. 40 catalogue *Adapter, RoleOf, HasRole* (inverse of *RoleOf), References, Many* (inverse of *References), Composes, IsOwnedBy* (inverse of *Composes), Aggregates, IsPartOf* (inverse of *Aggregates),* and *Uses. RoleOf* differs from the other kinds of relationships by implicating an inheritance relation. The role (i.e. the type having a *RoleOf* relationship with a base type) is a *dynamic subtype* of the base type and will inherit all the features of its supertype. This makes it possible for a business object to assume different roles, which are created and deleted dynamically during the lifetime of the object. As pointed out by [EDIG+98a] p. 18, delegation may be used as an implementation technique for roles in order to appropriate behaviour and data from the supertype of the role object.

[963] The handling of states will involve a fair amount of logic inside the business object implementations. Cf. [EDIG+98a] p. 14.

[964] The implementation of *during* in commonly used programming languages is troublesome. Cf. [EDIG+98a] p. 14 et seq., where the possibility of skipping implementation altogether is intimated.

[965] These were called *explicit events* in [DENS+97a].

[966] [DENS+98a] p. 25 et seqq. The full range of *implicit event producers* is given in p. 28. It includes attribute and relationship changes, state transitions, call/return/failure of operations, insertions and deletions from collections and relationships, creation and destruction of objects, and the initiation of a process.

pendency rule declare in which particular events the object takes an interest.[967] It is the responsibility of the implementation to handle the notifications, for which the object has declared its interest. The example below reveals the *CDL* syntax of signals:

```
entity WashingMachine {
   signal ButtonPressed(in short status);
   signal TemperatureSet(in short temperature);
   signal WaterEmptied();
   signal WaterFilled();
};
```

A dependency rule may look like this:

```
entity WashingMachine {
   relationship motor Composes 1..1 MotorType inverse is_part;
   apply Dependency motorOnOff {
      trigger=motor.running;
   }
};
```

Operations are method declarations to which may be added constraint declarations (pre- and post-conditions) and a number of feature parameters.[968]

```
entity WashingMachine {
   attribute float waterLevel;
   [preCondition=(waterLevel>0.25)]
   void Spin(in short velocity);
};
```

Appliances provide a "plug-in" facility, by which functionality – such as a business rule or an invariant – or specifications may be added or *applied* to a business object through an *apply statement.* This is, as it were, "the specification analogy to component assembly".[969] An appliance can have parameters, which may be used to adapt it for different purposes. It is possible to define new appliances, but very often one of a number of pre-defined appliances may be taken advantage of instead. These include:[970]

- *ECRule (EC = Event/Condition),* which is a rule that may be triggered by an event, provided a guard condition is true; since the *ECRule* lacks an action part, it is only useful when subclassed by an appliance definition
- *ECARule (ECA = Event/Condition/Action),* which is a rule that will perform a specified action when a guard condition is true and it is fired by an event
- *StateTransitionRule,* which defines when state should be changed

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[967] [EDIG+98a] p. 8 and 34 differentiate *intrinsic, implicit,* and *programmed events.* These concepts will be explained below on p. 204, where the difficulties in implementing the *CBOF* event model will also be given due attention.

[968] [DENS+98a] p. 35. [EDIG+98a] p. 13 hint at the difficulties of implementing pre- and post-conditions in languages not supporting these concepts – including all languages with *CORBA IDL* mappings authorised by *OMG* – and suggests that constraint-checking code be inserted into the relevant methods. Alternatively, pre- and post-conditions may be interpreted simply as a purely declarative "expression of the range of predictable behavior of the object".

[969] [DENS+97a] p. 29 Here it is also predicated that "appliances only affect the specification", at least until a *CORBA* component standard provides a corresponding "implementation concept of component assembly". On p. 172, it is however stated that "*appliances* and *rules* may be dynamically added to any object with dependencies on other existing objects without changing the implementation of either object". It is hard to see how this should be possible – *CDL* defines the interface of a component, and whenever an appliance is applied to it, the *CDL* interface definition is modified. In case *CDL* is not only used for textual specification, but e.g. for programme code generation, a change in the interface of the component will imply a fresh generation of code and an ensuing recompilation. If *CDL* is indeed used for textual specification only, the application of an appliance will undoubtedly entail also implementation changes, as could be realised from, for example, the discussion of the implementation of invariants in [EDIG+98a] p. 14.

[970] [DENS+98a] p. 29. A discussion of rules can be found in [DENS+98a] p. 42 et seq.

- *Invariant,* which specifies a condition that always must be true[971]
- *Dependency,* which is a declaration of interest in certain events
- *Label,* which provides a facility for translations of names into a certain language

Typical elements of rules include a *trigger* event, which fires the rule, a *guard* condition, which filters events and thus may put restrictions on the firing of rules, an *action,* which will be performed when the rule fires, and a *schedule,* which specifies exactly when an action should take place after the rule has fired. Below is an example of the application of an *Invariant* appliance:

```
entity BankAccount {
   attribute float balance;
   apply Invariant balanceOK {
      guard = (balance>=0);
      schedule = DoAfterSubCommit;
   };
};
```

Another example shows how to define an appliance *DriveRule* that inherits *ECRule* and adds a parameter *velocity* to the *ECRule* default ones *(trigger, guard,* and *schedule)* and how to apply the new appliance to an entity *Car:*

```
appliance_kind DriveRule:ECRule {
   attribute velocity=0;
};

entity Car {
   signal start();
   apply DriveRule drive {
      trigger={start};
      velocity=110;
   }
};
```

We have so far only discussed *features,* i.e. the building blocks from which *BOCA components* are assembled, so it is about time we examined the *BOCA components* themselves. There are four kinds of them:[972]

- *Business objects* are independent, identifiable objects
- *Subsystems* are identifiable module constructs used to group related components
- *Dependent objects* (or *dependents)* may only be attributes of business objects and cannot exist on their own
- *Appliances* have already been discussed above

Business objects represent things or processes in the business domain. They may be categorised by their usage as common business objects (i.e. objects common to many domains), common domain business objects (i.e. objects common to many products in a certain domain), and application specific business objects or application objects in *CORBA* parlance. Business objects are *CORBA* objects, and they are uniquely identified by *CORBA* object references.[973] Business objects are persistent, transactional, and secure. They are never

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[971] [EDIG+98a] p. 14 assert that invariants should be checked when a request for commit of a transaction has been done. In the interoperability specification, the *validate* method of the *TransactionalObject* interface seems to be intended for this checking (id op. p. 49 et seq.).

[972] [DENS+98a] p. 21

[973] Whereas *CORBA* entails support of multiple *interface inheritance,* it neither enforces, nor rules out *implementation inheritance.* [DENS+98a] p. 172 and p. 174 mention more or less *en passant* this most substantial extension to the *CORBA* object model as part of *BOCA*. What relevance implementation inheritance has to a *specification language* like *CDL* and a meta-model like *BOCA* is doubtful. [EDIG+98a] p. 20 do not champion *implementation inheritance* to implement specialisation, but considers it "desirable that specialization be supported without access to common business object source code".

passed by value, but may be moved. Business objects usually contain a set of *features* such as attributes, relationships, and operations. There are three types of *business objects:*[974]

- *Entities* define the object interfaces of things, persons, etc.

```
entity Patient: Person {
   attribute short weight;
};
```

- *Processes* represent activities that are typically extended over time. They are always attached to an enclosing business object such as an entity or another process, and they are *launched* relative to this enclosing object. They may be regarded as reified methods, although they differ from methods in a number of important respects such as having an extended lifetime, a visible state that may be accessed from outside and relationships to other business objects.[975]

```
entity WashingMachine {
   attribute string type;
   process Wash {
      relationship theWasher References WashingMachine;
      attribute short temperature;
      attribute float waterLevel;
      state washing (filling, washing, emptying);
   };
};
```

- *Business Events* "represent a persistent record of a change in the business at a particular instant in time, such as a purchase, sale or delivery".[976] In most respects business events function as entities. Here is an example:

```
business_event Delivery {
   attribute string delivery_id;
   attribute string haulier;
   relationship items References 1..* Product inverse delivery;
};
```

Subsystems group components together for some purpose.[977] They differ from plain *IDL* modules by being real objects that may contain features such as attributes, relationships, operations, etc. Models may inherit and aggregate other models.

```
subsystem MedicalRecord {
   entity Patient {};
   entity Doctor {};
   entity Hospital {};
   Patient searchForPatient(in string name);
};
```

Dependents are data attributes of *business objects*, lacking a unique identity and independent life cycle, since they only exist as parts of other business objects. They are accessed through accessor methods and must be passed by value, unless they are immutable, in which case they may be passed by reference as well. Dependents may be primitive values of types such as integer, string, or floating point number. They may also

---

974 In addition to *entity, process, subsystem,* and *business_event* there is a more generic *type* construct in *CDL* (called *component* in [DENS+97a]), corresponding to the *BocaType* meta-model concept. The *type* keyword is much used in the *CDL* definitions of various *BOA* concepts given in [DENS+98a].

975 [DENS+98a] p. 31 et seq. [EDIG+98a] p. 14 suggest that processes should be implemented in the same way as *entity* business objects.

976 [DENS+97a] p. 32

977 In [DENS+97a] subsystems were called models and were classified as a subtype of business objects. Traces of this former classification remain in [DENS+98a] e.g. in p. 30.

be *elementary* or *composite objects*[978], *collections* of different kinds (sets, bags, lists, arrays), or *command objects,* i.e. an object reifying an activity that does not transgress a single transaction. *Dependents* may be declared immutable by prefixing the *[FROZEN]* feature parameter.

```
dependent Address {
   attribute string street;
   attribute string zipCode;
   attribute string city;
   attribute string country;
};
```

The above type system is by no means, uncontroversial. The classification of business objects has, for example, been much debated.[979]

A *Business System Domain (BSD)* is a section of the distributed object universe meted out for a certain domain of interest. *BSDs* may be federated through objects having *adapter* relationships across the *BSD* borderlines.[980] *BSDs* make it possible to organise development efforts independently without excluding interoperability.

For every type there is a *type manager* object, which is a distributed class object responsible for attributes and operations that are common to all instances (i.e. the *extent)* of a type. Features may have *manager* as well as *instance* scope. Among the most important tasks of the *type manager* is to handle life cycle operations, including creation, deletion, copy, and move as well as activation and deactivation. Other responsibilities include the support of queries with type scope, introspective access to meta-data, and the management of type-based and relationship-based dependencies.

1.5.4.2 The Component Definition Language

The *Component Definition Language (CDL)* provides a syntactic interpretation of the *BOCA* meta-model, as has already been amply exemplified in the previous section.[981] Just like *CORBA IDL, CDL* is a declarative specification language, not a programming language, and its intended use is in the modelling and declaration of business object interfaces and their interrelationships along with various behavioural constraints and rules. A business object specification language, which allows for a higher level of semantic detail than pure *IDL,* may be useful e.g. for the work on the "vertical" domain interface standards that proceeds under the auspices of *OMG's Domain Technology Committee.*[982] The designers of *CDL* envision that *CDL* specifications will be generated from visual modelling tools, which may, for example, use the *UML* notation adopted by *OMG.*

As compared to plain *CORBA IDL, CDL* adds the possibility to declare some behavioural aspects such as constraints, rules, etc. in the interface of an object. For this purpose, expressions with a *Java*-like syntax are supported. Some shreds of *OCL (Object Constraint Language),* the constraint language defined as a part of *UML,* are supported as well.[983]

The relation of *CDL* to the lowlands of programme construction is not altogether limpid, although various suggestions are given in the *CBOF* documents.[984] *Figure 17* gives some hints about the possibilities

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[978] Elementary objects only contain one instance variable.

[979] The interested reader could follow the arguments in http://www.omg.org/archives/bomsig/

[980] [DENS+98a] p. 174 appear to use the term *domain model* synonymously with *BSD.* Here the phrase *contextual business solution* is also suggested as a replacement of *application* "to avoid potential negative and restrictive implications". Different *contextual business solutions* may use overlapping sets of business objects and interoperate in various ways.

[981] *CDL* is described at great length in [DENS+98a] p. 81 et seqq.

[982] Also industrial standardisation bodies other than *OMG,* e.g. *SEMATECH* and *OAG (Open Applications Group),* may take advantage of such a language. Cf. [DENS+98a] p. 172.

[983] [DENS+98a] p. 97. [OMG97p] is the document of definition of *OCL.* In the original *JBOF* submission, also *ODMG-93 ODL (Object Definition Language)* and *OQL (Object Query Language)* were included by reference (cf. [DSPI97] p. 14 et seq.).

[984] See e.g. [DENS+98a] p. 15, 82, 170 et seq.

considered, whereas *Table 2* summarises the options that suggest themselves with reference to the creation and usage of *CDL* specifications and *BOCA* meta-data. A *CDL* specification may either be automatically generated by an analysis/design tool or be put together manually. In the most straightforward case, the *CDL* specification will then simply be handed over to programmers to provide a textual basis for the hand coding of an implementation.

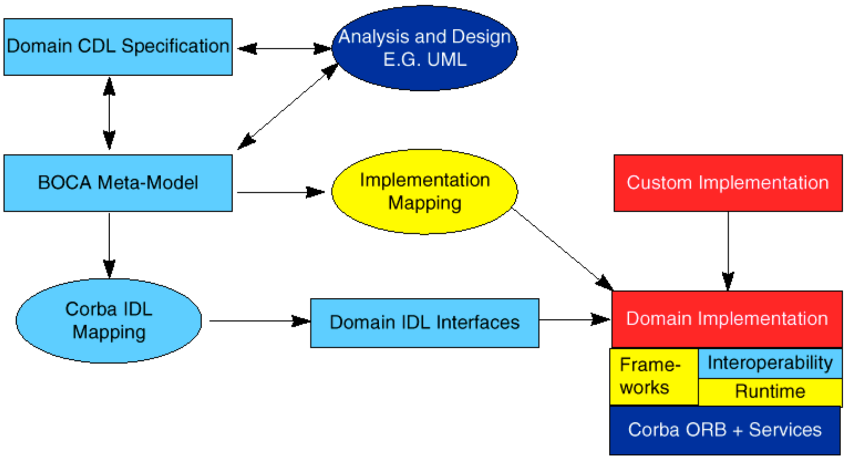

Figure 17. Suggested use of CDL and BOCA. By courtesy of Cory Casanave and the CBOF team.[985]

Since *CDL* is a proper superset of *CORBA IDL (Interface Definition Language),* adding enhanced semantic precision to *IDL* through a plethora of new keywords and constructs, the core parts of *CDL* may be directly mapped to *IDL* by using a *CDL*-to-*IDL* compiler.[986] In most cases, however, information will be lost if a translation of a specification is made from *CDL* to *IDL*.

CDL specifications may also be used to generate meta-data in a repository compliant with the *BOCA* meta-model, either as an alternative or as a supplementary technique to a direct *CDL-IDL* translation.[987] The latter supplementary technique may provide a way to avoid the information loss implied by a simple *CDL-IDL* translation. Of course, it will also be possible to generate *IDL* interfaces from meta-data in lieu of doing a direct *CDL-IDL* translation.

To disentomb and make use of the information buried as meta-data in some form of repository may, of course, be made the – probably not very agreeable – task of the programmers who implement the generated *IDL* interfaces in a programming language for which a *CORBA IDL* mapping exists. Alternatively, some kind of automatic tool can be used to generate programme code stubs from meta-data or directly from *CDL* specifications.[988] Such generated code may take advantage of a support framework, such as, for example, an implementation of the *Interoperability Specification* appended to the *CBOF* submission.[989] The *CBOF* proposal en-

[985] [DENS+98a] p. 15

[986] Such a *CDL*-to-*IDL* compiler was actually provided by *Data Access Corporation.*

[987] Reflective meta-data are fundamental to component technology and are widely used in *COM+/OLE/ActiveX, CORBA,* and *JavaBeans.* A good introduction (in pattern form) to reflection may be found in [BRMS+96] p. 193 et seqq.

[988] [DENS+98a] p. 82 foresee tools that "generate framework-compliant executable components from information in the BOCA Meta Model". It is, however, hard to realise how this could be possible without a complete behavioural specification of the methods of the business objects.

[989] In addition to the general unwieldiness of this approach, such reliance on code generation is known to be fraught with a variety of problems, including the difficulties of humans to understand machine-generated code, cumbersome cycle times, and the problems of synchronisation between multiple representations, whenever modifications are made in one of them. Ripple effects will haunt any multi-layered architecture and one based on code-generation in particular, causing repeated rebuilds and re-translations that will slow down the

visaged various *BOCA* tools using code generation as well as component assembly and framework technology as principal techniques.[990] These tools and frameworks would be built on top of the *CORBA ORB* and assorted *CORBAservices*.

	CDL declarations	BOCA meta-data
Origin	1. Assembled by hand 2. Generated by analysis/modelling tool	1. Generated from *CDL* declaration through a *CDL* compiler 2. Generated by analysis/modelling tool
Use	1. Textual specification 2. Generation of *BOCA* or other type of meta-data stored in e.g. a *MOF* or *CORBA* interface repository 3. Generation of *CORBA IDL* declarations 4. Generation of partial implementation code 5. As a basis for direct interpretation inside a (visual) programming tool, although such a tool would have to supplement the *CDL* specifications with a notation for specifying the behavioural implementation of operations	1. Direct employment by programmers 2. Generation of *CORBA IDL* declarations 3. Generation of *CDL* specifications 4. Generation of partial implementation code 5. Immediate interpretation in visual tools 6. Run-time reflection allowing e.g. dynamic discovery and invocation of a component's interface and dynamic checks of event interest registrations

Table 2. Comparison summarising the origin and use of CDL declarations and repository-based BOCA meta-data.

Run-time reflection, the last item on the list of potential uses of *BOCA* meta-data, goes beyond what is possible with *CDL* interface declarations only. Since standard *CORBA* dynamic invocation mechanisms make use of the *CORBA* interface repository, a *BOCA* repository will, however, not necessarily be the first choice for this type of functionality, at least not unless it somehow can be attuned to the *CORBA* interface repository.[991]

development process. The increased exposure of semantic detail in *CDL* interfaces also implies an increase in the fragility of interfaces and thus in the occurrence of such ripples and will further conduce to such slow-down. The *CBOF* model involves no less than six layers of representation, which should be kept synchronised and which ripples of change will have to traverse: *UML* diagrams, *CDL* specifications, *BOCA* meta-data stored in some form of (possibly *MOF*-compatible) repository, *IDL* interface definitions, *CORBA* interface repository meta-data, and implementation code. Each transformation is also a potential source of errors, which may be very difficult to pin down because of the multiplicity of the potential error locations and because of the obscurity of generated code.

In addition, it might be argued that for change propagation to work reliably in both directions within such a chain of transformations, humans should not have direct and unrestrained access to the various textual or visual representations of the code, but all modifications should rather be controlled by a tool that uses a representation database and a set of rules to determine whether a change is permissible or not.

The proliferation of layers and transformations does also seem to clash with pivotal ideas and sentiments of the business object movement about the importance of "rapid solution delivery", reduced cycle times and time-to-market, and "user solution composition" based on plug-and-play components (see e.g. [OMG96b] p. 3 et passim). Not only does each layer introduce a new semantic gap and a time-consuming and error-prone translation process, but the combination of layers and code generation seems to imply a relapse into the staged development habits characteristic of e.g. the time-honoured, but infamous waterfall model. As it appears, a reduction of the number of layers would be highly desirable.

990 [DENS+98a] p. 173 makes a sharp distinction between component building and component assembly/reuse. Some applications may be assembled from existing components only, whereas others will require new components to be built.

991 Generally speaking, the additional layers of *CDL* specifications and *BOCA* meta-data, introduced in order to enhance the semantic expressiveness of business models, imply a duplication of interface definitions and repository data that is bound to engender complexity and ambiguity. From a *CBOF* point of view, it would be advantageous if the *CORBA IDL* and *interface repository* layers were removed altogether, but that cannot happen unless a new generation of *CBOF*-compatible brokers supersedes the current *CORBA* breed of object request brokers.

1.5.4.3 The Interoperability Specification

So far, *CBOF* may have made a somewhat exsanguine impression; a semantically rich specification language and a meta-model may be good things, but where are the flesh and bones? The modelling abstractions will not alone be sufficient to create a *Business Object Facility,* but need to be eked out with implementation and infrastructure. This is where the *Interoperability Specification* fits in.

The *Interoperability Specification*[992], frequently also referred to as the *Interoperability Framework* in the *CBOF* documents, saw daylight as the *EDS Business Object Facility*[993] and was later appended as an adjunct to the *BOCA/CDL* submission. Although the original impression of being a postiche somewhat maladroitly tacked onto the *CBOF* proposal rather than a truly integral part of it gradually tapered off during the revision process, its relationship to the other *CBOF* elements remained fairly loose.[994] The attempts at integration with the concepts of *BOCA* and *CDL* that actually were made rather tended to lay bare the gap between those concepts and current programming language and distributed objects infrastructure technology.

The interoperability specification aimed at providing "a common technical infrastructure and protocols" for interoperable business objects.[995] It was also intended as a basis for "tools, components and frameworks to support the implementation of business objects—business object frameworks".[996] In particular, it addressed the problem of *interoperability* across heterogeneous business object frameworks as opposed to the related issue of *portability.*[997] The gist of the proposal consisted of a number of definitions of *interoperability interfaces.* There were three distinct categories of these:

- the business object interfaces, including *IndependentObject, BusinessObject, LifeCycleObject, Adaptor, RoleObject, RoleParent, StateAccess,* and the event notification interfaces *Supplier* and *Consumer*
- the type manager interfaces, which comprised *BasicTypeManager* and *TypeManager*[998]
- the *shared services* interfaces, encompassing a modified *CORBA* transaction service, a new dispatch service closely related to the transaction service, and a modified *CORBA* name service[999]

The *business system domain (BSD)* concept is central to the interoperability specification.[1000] Within a *BSD,* there should be a one-to-one mapping between business objects and real-world objects, whereas several different business objects belonging to distinct *BSDs* may correspond to one real-world object. Inter-domain sharing could be achieved by using an *adaptor* that provides translation and adaptation of the interface of an object situated in an external *BSD.* The *BSD* also defines the scope of consistency and recoverability: Within one *BSD,* objects should be in a consistent state, and the domain of transactional recoverability is the *BSD.* Furthermore, the *BSD* defines a name scope for business objects, the scope of type manager extents[1001], and a

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992 [EDIG+97] is the November revision, and [EDIG+98a] the final submission. The final submission has assimilated a number of ideas from the *IBM/Oracle/Visigenic* proposal, including support for *dynamic properties, topologies,* and *command* and *application control objects. Command objects* are supposed to be passed from thin clients to server-based business objects to start some kind of processing. *Application control objects* also belong to the domain of thin clients and provide operations pertaining to user sessions (see [EDIG+98a] p. 63 et seq.). *Dynamic properties* and *topologies* will be explained below. The devious paths of the *Interoperability Specification* during the spring of 1998 have been recounted above (see p. 189 et seqq.); [EDGN+98b] was the last version of it, dated May 18, 1998. We will focus on the [EDIG98a] document here, but give occasional hints of the subsequent modification made to it.

993 [EDS97]

994 Cf. [EDIG+98a] p. 1 and p. 101 et seq. and [EDGN+98b] p. 109 et seqq.

995 [EDIG+98a] p. 101

996 [EDIG+97] p. 3.

997 Cf. p. 188 above.

998 In [EDGN+98b], *BasicTypeManager* and *TypeManager* were merged into a single *TypeManager* interface.

999 The existing *CORBA* security and event services are also needed as parts of the business object infrastructure proposed in the submission. In [EDGN+98b], the original *COS Transaction Service* is relied upon and the *dispatch service* has been removed again.

1000 [EDIG+98a] p. 15 et seqq.

1001 The *extent* of a type is the set of all objects of that type within a particular *BSD.*

boundary, which relationships are not allowed to cross.[1002] *BSDs* may also define the domain of a certain security policy. Each *BSD* is represented by a special business object variously called a *domain manager object* or a *business system domain object,* which will include various items of information about the domain.

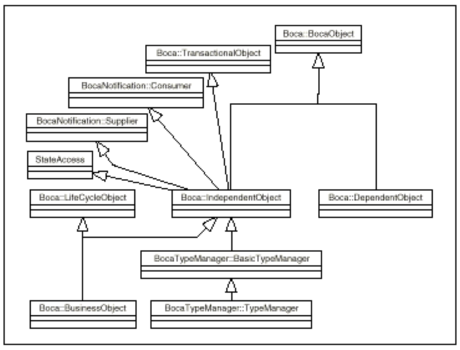

Figure 18. The core CBOF interoperability interfaces. Courtesy Fred Cummins and the CBOF team.

The inheritance relations between some of the most important *interoperability interfaces* are shown in *Figure 18.*[1003] As can be inferred from this diagram, there is not a simple one-to-one mapping between the *BOCA components* and *CDL* constructs on the one hand and the interoperability interfaces on the other. The basic *CDL* concepts *entity* and *process* both map to *BusinessObject,* whereas *dependent* corresponds to *DependentObject.* Various guidelines are offered on how to translate some of the more difficult *BOCA components* into implementation code.[1004]

At the root of the inheritance tree is the *BocaObject* interface, which is the common ancestor of both independent and dependent business objects. This interface does not define any operations or attributes.[1005] The *DependentObject* interface is inherited by objects that are used as attributes and lack unique identity. Such objects partake of the persistence, transaction, concurrency, etc. properties of their owning independent business object. *DependentObject* only defines one operation, which makes it possible to check for equality between two dependent objects. [1006]

In contrast to dependent objects, independent *business objects* inherit from the *BusinessObject* interface and are *CORBA* objects, uniquely identified by *CORBA object references.* Since they may be shared by multiple users, they will need to be transactionally accessed. They are supposed to be persistent in most cases, although the *CBOF* interoperability specification does not address persistence issues.[1007] Business object interfaces are built from a variety of *features.* Some of the *feature* types defined by *BOCA,* viz. *attributes, relationships,* and *operations,* have simple enough *IDL* and implementation code interpretations and are supported in a straightforward way by the interoperability specification, whereas the others – i.e. *state sets, signals,* and *apply* statements – will need more implementation work and have considerably more tenuous relations to the interoperability interfaces. The interoperability specification also adds interfaces through which properties may be dynamically attached to business objects during run-time.[1008]

[1002] Adaptors are allowed to have cross-*BSD* relationships with their primary objects.

[1003] [EDIG+98a] p. 23. Several minor inconsistencies between this figure and the other parts of the documentation exist with reference to module names as well as module affiliation. *Boca* is elsewhere (e.g. in p. 83) called *BocaObjects,* and on p. 84 *StateAccess* belongs to *BocaObjects,* whereas according to e.g. p. 89 *TransactionalObject* does not – it is there made a member of the module *BocaTransactions. DependentObject,* on the other hand, in p. 94 belongs to the module *BocaGenericDataTypes* rather than to the non-existing *Boca.* In [EDGN+98b], the inadvertencies have been sorted out: *BocaObject* and *DependentObject* belong to *Boca, TransactionalObject* to *BocaTransactions, Consumer* and *Supplier* to *BocaNotification,* and *StateAccess, IndependentObject, LifeCycleObject, BusinessObject,* and *TypeManager* to *BocaObjects,* whereas *BasicTypeManager* has been removed.

[1004] [EDIG+98a] p. 13 et seqq. Cf. also id. op. p. 102.

[1005] This has changed in [EDGN+98b], where *BocaObject* exposes one operation for comparing itself with another *BocaObject* and another one for retrieving its own class (i.e. *BocaType)* object.

[1006] In [EDGN+98b], *DependentObject* does not add any operations to those of its ancestors, *BocaObject* and *CosTransactions::TransactionalObject.*

[1007] Cf. [EDIG+98a] p. 68. At the time, work was going on to define the *CORBA Persistent State Service (PSS)* that was to replace the not very widely implemented *CORBA Persistent Object Service (POS).* The *CBOF* submission did not depend on any of these, but expressed the surmise "that business objects frameworks implementing this specification may use the PSS in the future".

[1008] Cf. [EDIG+98a] p. 61 et seqq. These interfaces, which duplicated the functionality of the *CORBA property service,* were removed in [EDGN+98b].

The *BusinessObject* interface accommodates a number of *generic protocols,* which serve as templates for the automatic assemblage of attribute access and relationship management methods.[1009] For example, there will be special accessor methods for getting and setting each attribute, the former with the same name as the attribute, the latter with the attribute name prefixed by *set_*. Besides ordinary attributes, attributes having multiple values may be used to form *virtual collections* and there are template methods for iterating over such a collection, adding to it, removing from it, etc.[1010] In addition, the *BusinessObject* interface assembles a number of other interfaces together by inheritance:[1011]

- *LifeCycleObject* is a replacement of the *LifeCycleObject* interface of the *CORBA* life cycle service and includes the *copy, move,* and *delete* operations.[1012]
- *IndependentObject* contains methods, *get_type* and *get_type_manager*[1013], which could be utilised to get the *type* of an object (as a string) and a reference to its *type manager,* respectively. There are also methods for the retrieval of three different identifiers: The *get_key*[1014] operation retrieves the *object key*, an object identifier unique "within the extent of its most general type manager", whereas a *framework identifier,* identifying the business object framework used by the object, could be got at by calling the *get_Boca_framework_id* method. A *get_persistent_id* operation is used to access the *persistent identifier,* consisting of the type identifier and "an implementation-specific opaque object identifier which incorporates the key".[1015] Another method, *is_identical,* may be used to check, if an object reference refers to the current object, and there are two methods, *add_to_relationship* and *remove_from_relationship,* intended for the update of bi-directional relationships.[1016] Additionally, *IndependentObject* inherits no less than five interfaces:[1017]
- *BocaObject* is the common root of independent and dependent objects.[1018]
- *StateAccess* supplies methods for setting and getting sets of attributes within one operation, thereby potentially reducing network traffic significantly.
- *BocaNotification::Supplier* and *BocaNotification::Consumer* are interfaces needed for the event model, which we will come back to below.
- *BocaTransactions::TransactionalObject* inherits the *CORBA OTS (Object Transaction Service)* interfaces *CosTransactions::TransactionalObject* and *CosTransactions::Resource*, of which the former signals that an object is transactional[1019] and the latter forces the object to implement trans-

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1009 [EDIG+98a] p. 26 et seqq.

1010 [EDGN+98b] adds the methods *get_type_manager, add_to_relationship, remove_from_relationship* (all three formerly situated in *IndependentObject),* and *will_notify_for_relationship*.

1011 In [EDGN+98b], *BusinessObject* also inherits *BocaRole::RoleParent* in addition to the interfaces mentioned above. The *RoleParent* interface enables a business object to take on an indefinite number of roles, i. e. objects of the type *BocaRole::RoleObject*.

1012 It differs from the *CORBA* life cycle service by using *Location* objects instead of *factory finders*. A *Location* specification comprehends three parts or *topology elements: cell, host,* and *server*. A *cell* signifies a geographical location having many *hosts*. Each *host* is a computer that may contain any number of *servers,* which are the actual address spaces in which objects are activated. Cf. [EDIG+98a] p. 31 et seqq. and p. 64 et seq. For a discussion of *factory finders,* refer to [Sieg96] p. 158 et seqq. In [EDGN+98b], the three topology elements were replaced with a single *Uniform Resource Locator (URL),* although the *URL* is still wrapped inside the *Location* object. In addition, the life cycle operations were renamed *copy_object, move_object,* and *delete_object* in this document.

1013 [EDGN+98b] moves the *get_type_manager* operation to the *BusinessObject* interface; otherwise type managers, which inherit *IndependentObject,* would have higher-order type managers.

1014 This operation is renamed *get_key_object* in [EDGN+98b].

1015 [EDIG+98a] p. 25. How to tackle the "weak client problem", arising from the use of the object type as part of the identifier, is not elaborated on. Cf. footnote no. 748 on p. 157.

1016 The reason why the ordinary *CORBA* relationship methods cannot be used for such updates is their liability to infinite recursion. Still, the location of the update methods in *InteroperableObject* rather than in *BusinessObject,* where the other relationship management operations are, was somewhat odd, and in [EDGN+98b] they were moved to *BusinessObject*. The *SSA* submission solves the same problem – and avoids method duplication at that – by the use of *hop counts* (see footnote no. 822 on p. 171).

1017 In [EDGN+98b], *IndependentObject* inherits a sixth interface as well, viz. *CosTransactions::TransactionalObject*.

1018 Whereas *BocaObject* lacks operations in [EDIG+98a], [EDGN+98b] endues it with the two operations *equals* and *get_class*.

1019 This implies that the transaction context will be inserted automatically and transparently into all calls of its operations.

actional methods like prepare, commit, and rollback.[1020] In addition, the *TransactionalObject* interface itself adds the methods *propagate, validate,* and *synchronize.*[1021]

The *ad hoc notification* event model promulgated by the *CBOF* submission was perhaps its most controversial part.[1022] The term *ad hoc notification* or *request events* is used to denote a mechanism whereby an *event consumer* may request *notifications* of any event that may happen in an *event supplier* or even – through the type manager – any event that may happen in any instance of a certain type. This facility is claimed to be "essential for composing systems from independently developed business objects".[1023]

In *CDL,* a business object registers its interest in a particular event by an interest declaration couched as a *dependency rule* in the client object.[1024] In the interoperability specification, every business object implements the *Supplier* and *Consumer* interfaces.[1025] The *Supplier* interface provides methods for entering and removing *Consumer* interest registrations for a single event or for a set of events. The *Consumer* interface inherits the *CosEvents::PushConsumer* interface from the *CORBA* event service without adding any operations of its own. *PushConsumer* includes the important *push* operation that will be called by the supplier whenever a notification is sent to the consumer. The actual notification will be passed in the *data* argument of *push.*[1026]

The submission distinguishes *intrinsic events,* which pertain to changes in the *computational state* of a business object, *implicit events,* which occur when the value of an attribute or a relationship changes or an operation is invoked or terminated, and *programmed events,* which correspond to the *signals* of *BOCA.* There are five different *intrinsic events: Created* and *Deleted,* which are issued when an object is created or deleted, *Committed* and *RolledBack,* which occur when an object is committed or rolled back in a transaction, and *Polling,* which is used to check if an event consumer is still active.[1027] *Polling* and *Deleted* will be sent to all consumers that have registered for events with the current supplier, regardless of if these two particular notifications have been requested.[1028]

1020 In [EDGN+98b], *TransactionalObject* does not inherit any other interfaces at all, whereas *IndependentObject* inherits *CosTransactions::TransactionalObject* in addition to *BocaTransactions::TransactionalObject.*

1021 These operations will be explained below on p. 206. [EDGN+98b] eliminates *synchronize.*

1022 *Ad hoc notification* is only required for *full compliance* with the interoperability specification and not for *basic compliance* – it is realised that "under some circumstances it may be difficult or impossible to implement these facilities". See [EDIG+98a] p. 103. In [EDGN+98b] p. 113 et seq., *ad hoc notification* was not present in the list of "optional features", whereas id. op. p. 6 indicated that it remained optional.

1023 [EDIG+98a] p. 8

1024 [DENS+98a] p. 25 et seqq.

1025 [EDIG+98a] p. 38 et seqq.

1026 Cf. [Sieg96] p. 196 et seqq. Since the registration operation in *Supplier* takes a *Consumer* rather than a *PushConsumer* argument, the introduction of a special *BOCA Consumer* interface seems to have the disadvantage of complicating the decoupling of consumer and supplier through the use of *CORBA event channels,* which implement the original *CORBA PushConsumer* interface. Such decoupling through an *event channel* would make it possible to send asynchronous notifications in addition to synchronous ones. An asynchronous notification will, however, cross transaction boundaries and, thus, may jeopardise the consistency of a system, in case the notification has side effects inside the notified business object – and indeed side effect-free notifications seem to be of very limited use. Cf. also [EDIG+98a] p. 52.

1027 *Created* may only be requested from *type managers* with *after* occurrence and *committed* delivery (see footnote 1028). [EDGN+98b] adds a *Moved* event, which is caused by the *move_object* operation.

1028 Additionally, various options must be set when registering interest in an event, viz. *occurrence, delivery,* and *persistence.* The *occurrence* of an event may be either *before* or *after* the action reflected by the event or, alternatively, *failed,* if notifications about exceptions and failures with reference to the action are desired ([EDGN+98b] calls the occurrences *BeforeAction, AfterAction,* and *FailedAction* instead). Only *implicit events* with *immediate delivery* may occur either *before* or *after* an action, whereas *intrinsic* and *programmed events* and events with *pre-* or *post-commit delivery* always occur *after* the action.

In the *after* case, the *delivery* of the event notice may be *immediate, pre-commit,* or *post-commit,* whereas in the *before* case, delivery is always *immediate. Immediate delivery* implies that notifications are sent synchronously with no delays. *Pre-commit delivery* occurs only immediately before a transaction commits, during its *propagation phase,* and implies that the notifications will propagate the transaction context and that their effects may be committed or rolled back as part of the transaction. *Post-commit delivery* occurs after a transaction has committed and implies that the notifications will propagate the transaction context of a new, top-level transaction and that their effects may be committed or rolled back as part of that transaction.

The main problem with the above design lies with the *implicit events*. If an external event consumer may register for notifications about an arbitrary attribute or relationship change, state transition, operation call/return/failure, etc., some piece of code must check for pending registrations, whenever any of these candidate event generators happen. This will potentially complicate the implementation of business objects beyond all reason, requiring such checks being made almost everywhere in the code. The result will likely be massive code bloat and, possibly, plummeting performance as well.[1029]

Three *business object interfaces* remain to be described: *RoleObject, RoleParent,* and *Adaptor*. The *RoleObject* interface incorporates methods for setting and getting the role parent object, whereas *RoleParent* supports adding and removing role objects as well as accessing them and iterating over them.[1030] The *Adaptor* interface only contains a method for retrieval of a foreign object identifier.[1031] *Adaptor* objects will inherit from this interface and add specific operations adapting the foreign object methods.

There is a fundamental duality between a type (inheriting the *BusinessObject* interface) and its type manager (inheriting the *TypeManager* interface).[1032] The type manager acts as the class object of the business objects of a certain type, managing all functionality that has class rather than instance scope. The type manager functionality is divided between a more basal *BasicTypeManager* class and its specialisation *TypeManager* harbouring the more advanced features. This division mirrors two different compliance levels.[1033] The *BaseTypeManager* interface includes instance factory methods and methods for mapping keys into references and vice versa[1034], whereas *TypeManager* adds methods for getting meta-information about the class it manages[1035], methods for iterating and making queries over the extent (i.e. all instances) of the type, and methods for the registration of interest in particular events in all instances of the class.

The *shared services* include an extended variant of the *CORBA Object Transaction Service (OTS)*[1036], and an adaptation of the *CORBA* name service to *BOCA* naming and exception schemes.[1037] A new *dispatch service*

Finally, interest registrations have a *persistence* attribute, which may be set to either *transient* or *persistent*. *Transient* registrations are not transactioned and will not be preserved over a system shutdown or failure. *Persistent* registrations are part of transactions and will be saved in a database so as to make them recoverable in case of system failure.

Whether *immediate delivery* of notifications implies propagation of the transaction context is not explicitly stated in the submission, but since the proposal implies that event suppliers will call the *push* event notification method of consumers synchronously and *CORBA OTS* transaction contexts will be propagated clandestinely by *OTS*-compliant *CORBA ORBs* in the calls of the operations of interfaces inheriting *CosTransactions::TransactionalObject,* which indeed is among the ancestors of the *BOCA IndependentObject*, this should be the case.

The need for the *before occurrence* and *pre- and post-commit delivery* of notifications is moot. Since *immediate delivery* will be synchronous and thus will propagate the transaction context, the object notified through *immediate delivery* becomes part of the transaction, and any recoverable changes caused by the notification will not be committed until transaction commit time anyway. The support for *pre- and post-commit delivery* seems to be a major source of complication and was one of the factors that underlay the redesign of the *CORBA Object Transaction Service* and the introduction of a distinct *Dispatch Service* supporting *post-commit* requests.

[1029] If some form of infrastructure facility did the monitoring, this objection would abate, at least partly. Apparently, such infrastructural monitoring will only be possible as part of the run-time components of language implementations.

[1030] [EDIG+98a] p. 39 et seq.

[1031] [EDIG+98a] p. 40

[1032] See [EDIG+98a] p. 41 et seqq. Cf. also p. 10 et seq.

[1033] *Full compliance* requires support for *ad hoc notification,* for the *StateAccess* batch get/set operations for attributes and relationships, and for the *TypeManager* interface. If *basic compliance* is opted for, the first two features may be disregarded and only the *BasicTypeManager* interface must be supported. The *legacy wrapper* level does not enforce any support for type management at all. Cf. [EDIG+98a] p. 103 et seq. In [EDGN+98b], there is only a single *TypeManager* interface accommodating the functionality of both former interfaces. In addition, the requirements for the compliance levels have been completely changed (see p. 113 et seqq.).

[1034] The interoperability specification contains some support for no less than five different ways of identifying business objects: *CORBA object references,* object keys, persistent identifiers, external identifiers, and qualified names. This proliferation of identification methods seems discomfiting. See [EDIG+98a] p. 53 et seqq.

[1035] This method has been removed in [EDGN+98b].

[1036] See e.g. [Sieg96] p. 205 et seqq. or [OHE96b] p. 124 et seqq.

[1037] [EDIG+98a] p. 12 et seq. and p. 51 et seqq. Critics argued that any necessary modifications to specific *CORBAservices* ought to be made in the service specifications themselves and not in a separate specification for an interoperability framework, lest *CORBA* should break down into a number of competing variants.

makes it possible to request actions and events to happen after the current transaction has committed.[1038] The *CORBA* security, event, and collection services have not been modified, but will probably be used by implementations of the interoperability specification.

The transaction service extends *CORBA OTS* by the support for a *session* object[1039], by a deadlock detection scheme[1040], and by the addition of three more phases to the well-known two-phase commit scheme. The new transaction phases introduced by *BOCA* proposal are[1041]:

- *The propagate phase* will occur after *commit* has been requested by the transaction client, but before *validate, synchronize, prepare,* and *commit* are issued by the transaction co-ordinator. *Propagation requests* may have side effects and appear mainly to be intended for the *pre-commit delivery* of event notifications.[1042]

- *The validation phase* will occur after *commit* has been requested and after the *propagate* phase, but before *prepare, synchronize,* and *commit*. *Validation requests* are not allowed to have any side effects and are intended mainly for invariant checking. If a validation fails, an exception will be thrown and the transaction will be rolled back.[1043]

- *The synchronize phase* will occur after *commit* has been requested and after the *propagate* and *validate* phases, but before *prepare* and *commit*. When *synchronize* is received, objects may "transfer their state to the persistent storage facility before the storage facility begins to

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[1038] In the fundamental revision of the *transaction service* made in [EDGN+98b], the *dispatch service* has been removed.

[1039] The *session object* provides a possibility to attach arbitrary contextual information to a transaction – such information may be used as hints by an implementation. In [EDGN+98b], the *Session* interface has been replaced with a *CurrentSession* interface that wraps the *transaction service* by inheriting from *CosTransactions::Current* and that adds methods for the registration of transactional objects for the *propagate* and *validate* transactional phases besides the methods for setting and getting contextual information. Notably, *CosTransactions::Current* exposes the *begin, commit,* and *rollback* operations that will be called by clients in order to demarcate transactions.

[1040] Immediately before a transaction is about to be suspended in order to allow another transaction to finish, it may call the deadlock detection mechanism to check out if the suspend will cause a deadlock. If that is the case, it should terminate rather than suspend itself. For deadlock detection to work correctly, the transaction service must be notified through a certain operation, whenever a transaction actually suspends itself. The methods needed are located in the *BocaCoordinator* interface, which inherits from the *CosTransactions::Coordinator* interface:

```
interface BocaCoordinator : CosTransactions::Coordinator{
    WillDeadlock will_deadlock_transaction(in CosTransactions::Coordinator pending_tc);
    void waiting_for(in CosTransactions::Coordinator tc);
    void register_with_priority(in CosTransactions::Resource resource,in Phases phase_priorities);
};
```

As it appears, the deadlock detection mechanism would be liable to race condition problems. Between the points in time when *will_deadlock_transaction* returns and the *waiting_for* and *suspend* calls are issued, anything may happen that makes the return value of *will_deadlock_transaction* obsolete. Additionally, as pointed out by Ed Cobb in [Cobb98a], a comment to the *BOCA* transaction service, in many cases such a mechanism would not be able to build the complete locking graph and thus could not analyse the deadlock risks reliably. Consequently, the deadlock detection mechanisms were removed from [EDGN+98b], as was the *BocaCoordinator* interface.

[1041] Each resource uses the *register_with_priority* operation of *BocaCoordinator* to register all phases it wants to take part in together with their priority values. For each phase command, the priorities will be used by the transaction co-ordinator to order the receipt of the command amongst the transactional resources. Resources that want to receive the new *propagate, validate,* and *synchronize* messages must implement a *BOCA* variant of the *TransactionalObject* interface, which accommodates these operations in addition to the ordinary *CosTransactions::Resource* operations *prepare, commit, rollback,* etc.

In [EDGN+98b], registration is made with the *CurrentSession* object instead and the priority mechanism has been removed. Furthermore, the *TransactionalObject* interface, which exposes the *propagate* and *validate* operations *(synchronize* has been removed) that are called by the *transaction service* during the corresponding transactional phases, does no longer inherit any *CosTransaction* interfaces, whereas the *IndependentObject* interface, while still inheriting *BocaTransactions::TransactionalObject,* has been made descendant also of *CosTransactions::TransactionalObject.*

[1042] Cf. [EDIG+98a] p. 36. As has been pointed out in footnote 1028 on p. 204, the need for pre-commit delivery of events is questionable.

[1043] Cf. [EDIG+98a] p. 67 et seq. and p. 14, where, however, the evaluation of invariants is wrongly attributed to the dispatch service. Why invariant checking cannot be done during the *prepare* phase, is nowise clarified in the specification.

perform updates", whereby the risk of "redundant I/O operations" is supposed to be eschewed, in case many business objects should update the same records.[1044]

Each business object will have to implement the *propagate, validate,* and *synchronize* in addition to the *prepare, commit,* and *rollback* operations. In *CORBA OTS* parlance, a business object will be a *recoverable server* and *resource* by virtue of its support for the two-phase commit messages *prepare, commit, rollback,* etc.[1045]

The *dispatch service* is intended to supplement the transaction service by support for three kinds of cross-transaction messages:[1046]

- *post-commit requests* will be delivered after the *commit* of the current transaction in the context of an entirely new transaction; such *chained transactions* may be useful e.g. when building workflow applications
- *timeout requests* are executed a specified period of time after *commit*
- *event delivery requests* are event notices delivered to an event consumer after *commit*[1047]

Objects to which non-event requests will be dispatched must support the *DispatchTarget* interface.[1048]

A general criticism that might be levelled against the *CBOF* event and transaction handling mechanisms is that they tend to exacerbate rather than to alleviate the complexities of *CORBA* programming – to say nothing about the complexities of implementing a *CORBA* infrastructure. The proposed mechanisms all add new complicated features, the need for which is rarely properly substantiated in the specification and in almost no case beyond doubt. Outside these areas, the proposal relies almost entirely upon the *CORBA* infrastructure apparatus and will in no way shield the business programmer from its many arcane aspects. The idea emphasised by the *RFP*[1049] that business object programmers should be domain specialists rather than technology pundits has clearly not been the guiding star of the *Interoperability Specification.*[1050] Although the specification improved significantly for each new version that appeared and many of its more obvious problems were finally weeded out, it nevertheless remained beclouded by contentious issues and proposals of dubious merit, as should be clear from the discussion and the comments above.

[1044] [EDIG+98a] p. 48. Why this could not be done during the *prepare* phase is not explained. In a distributed system, the multiplication of phases also implies a most unfortunate multiplication of cross-network messaging. Additionally, the intention of the *synchronize* message seems to have at least some overlap with that of the *Synchronization* interface of *CORBA OTS 1.1*. In [EDGN+98b], the *synchronize* phase was removed.

[1045] It may turn out to be a very arduous task to programme these operations in every business object, at least if this implies that the objects will have to act as full-fledged resource managers themselves, implementing the advanced *ACID* functionality found in a *DBMS*. According to Ed Cobb (see [Cobb98a]), the *Resource* interface was never intended for use by business-level programmers, but rather for tasks such as the implementation of an object-oriented database system. In [EDGN+98b], business objects no longer inherit the *CosTransactions::Resource* interface and, thus, do not need to implement *prepare, commit,* and *rollback,* although they still will have to implement the new-fangled *prepare* and *validate*.

[1046] [EDGN+98b] does away with the *dispatch service* altogether.

[1047] Cf. footnote 1028on p. 204.

[1048] This interface exposes two methods:

```
interface DispatchTarget {
    void dispatch (in DependentObject parameter);
    void timeout (in DependentObject parameter);
};
```

[1049] E.g. [OMG96b] p. 4.

[1050] [DENS+97a] p. 164 contends that surface area (cf. footnote 722 on p.152) is reduced by a standardisation of "the way in which CORBAservices are composed, configured, and specialized". In addition, it is argued that *BOA* "reduces surface area and/or complexity by providing a domain-oriented abstraction model which enables the user to focus on his domain problem". This could be disputed, since the *BOCA/CDL* proposal considerably increases the number of items exposed in the interface of an object as compared to e.g. *CORBA IDL*.

1.5.5 CODA ON THE *OMG* BUSINESS OBJECT EFFORT AND *CBOF*

It hardly makes much sense to expatiate further on the advantages or disadvantages of the technology that might have resulted, had the *BODTF* events taken another course, let alone to pillory designs that never reached the maturity and finality that would allow us to judge them fairly. Arguably, the *BODTF* failure does, however, cast some light on the tribulations that the reliance on a design-by-committee process, such as that of *OMG,* may implicate in efforts that aim at the development of *novel* technology. Although the support and hallmark of an independent standardisation body and the opportunity to draw on an existing technology foundation, such as that of *CORBA* and the *CORBAservices,* may be of great value, the political concerns and the incessant negotiations and compromises implied by the committee approach will complicate such development efforts considerably and will be apt to endanger the conceptual integrity of the designs worked at to boot. Additionally, also largely unproven or unfinished designs, still being, as it were, on the drawing board, may slip through the *OMG* process as a consequence of the rather conniving proof of concept requirement of the *OMG* by-laws. Certainly, a more informal *R&D* organisation will in most cases provide a better setting for the gestation, exploration, testing, and stepwise refinement of new technology than the committees of standardisation consortia; as a rule, a technology should not be a candidate for standardisation until it has reached a reasonable level of maturity and been proven in real life. For one thing, the *CBOF* proposal resulting from the *BODTF* process would have gained both in quality and in credibility, if an implementation of something like the tools suggested by *Figure 17* had been in existence before the *OMG* adoption process was embarked upon.

As the *CBOF* proposal stands, there is, aside from various obscurities and contentious issues, of which some have been discussed above, a general vagueness about how the proposed technologies are supposed to be used. The most obvious use of *CDL* would be as a textual *specification language,* somewhat akin to the *Architectural Design Languages (ADLs)* advocated by some proponents of *software architecture*[1051]*,* although many will surely question the usefulness of detailed textual specifications above and beyond ordinary narrative descriptions and the well-known graphic models of *UML* and kindred object-oriented modelling and design approaches. And even though this is only hinted at in the *CBOF* proposal, the submitters clearly envisioned the *CDL* language and *BOCA* meta-model to be combined with a generative approach much like that to be found in the *application generators, 4GL,* and *CASE* tools traditionally popular within "business programming" – such as *Data Access'* object-oriented *DataFlex* or *Texas Instruments'* component-oriented *Composer* tools of this kind.[1052] Although admittedly generative tools may make for impressive levels of productivity and much interesting research has gone into the field of "automatic programming" and promising work is still going on[1053], the generative approach is also haunted by its own imbroglio of problems and liabilities.[1054] Hence, it does not constitute our preferred path, at least not as a general approach to software development.

At a more fundamental level, we beg to differ with the goals and the approach of *BODTF* in two respects:

1) *Emphasis on middleware business objects.* In our view, the greatest potential of *business objects* will be as directly user-manipulable "thing-like" objects in a *GUI*, whereas the aptitude of *business objects* in the middle layers of multi-tier client/server systems is moot. It seems that there are at least three cumbers here that all tend to undermine the view that *business objects* or kindred approaches, such as *entity Enterprise JavaBeans (EJBs),* will be a good idea in middleware: 1) the difficulties to easily adapt to multiple data models 2) the inflexibility and complexity (and ensuing development cost) of multi-tier object-oriented solutions 3) the architectural mismatch with state-of-the-art (i.e. *MTS/COM+* and *session EJBs)* transactional "stateless" components, which are short-lived and not very object-oriented in nature.[1055]

1051 [BCK98] p. 267 et seqq.

1052 Cf. [Szyp98a] p. 247. *Sterling Software* (now a part of *Computer Associates),* later acquired *Composer.* For more information on *Sterling's COOL* product line, see http://ca.com/acq/sterling. Product information on *DataFlex* is available at http://www.dataaccess.com.

1053 See [RW92], [Bigg97], and [SB]. Two important research groups in this area are the *Software Systems Generator Research Group* of the *University of Texas* and the *Software Sciences Division* of the *Information Sciences Institute* of the *University of Southern California;* see http://www.cs.utexas.edu/users/schwartz and http://www.isi.edu/software-sciences/home-page.html.

1054 We have highlighted some of the issues in footnote 989 on p. 199.

1055 See the section on "middleware" business objects on p. 114 et seqq. above and, in particular, the footnotes 495 and 498. Cf. also below p. 579 et seqq. and [FMMS00].

2) *IDL framework-orientation.* We are sceptical of the suitability both of *Interface Definition Languages* (such as *CDL)* and of *object-oriented frameworks* for the development of business software. In our contention, these approaches tend to breed complexity, reduce productivity, and increase surface area, which, in particular, will be ballooned by the inclusion of behavioural aspects and other excrescence into the interface of objects suggested in the *CDL* proposal.[1056]

In conclusion, our own vision of *business objects,* their preferred appearance, rôles, and properties, and their "Sitz im Leben" seems to be fundamentally at odds with the one that came out of the *BODTF* effort.

[1056] See below p. 254 et seqq. for a somewhat more detailed critique of object-oriented frameworks. Cf. also [ER97a].

1.6 BUSINESS OBJECTS AND THE *MICROSOFT* TECHNOLOGY SPHERE

Business objects is not a term that plays a very important rôle in *Microsoft's* writings and discourse on its own strategies and technologies – on the contrary, the golden calf worshipped at *Microsoft* is *components,* and indeed the component calf has rewarded its worshippers bountifully, insofar as components have been instrumental in *Microsoft's* tremendous commercial successes. Unsurprisingly, in *Microsoft's* understanding *business objects* are closely related to the component technology *COM/ActiveX,* presently to be replaced by *.NET.* Furthermore, in documents issuing from *Microsoft* the term *business object* is used almost exclusively in the context of client/server development[1057], and *business object* is understood in two distinct and quite technical ways corresponding to the "analysis object" and the "middleware object" interpretations mentioned initially.[1058] Below, these will be briefly explained and surveyed as will Rockford Lhotka's ambitious attempt to give *business objects* a pivotal rôle in client/server development based on *Microsoft's* tools and infrastructural technologies.

1.6.1 BUSINESS OBJECTS IN *COMPONENT-BASED DESIGN*

The "analysis object" usage of *business object* is common in *Microsoft* writings that deal with the three-phased design method occasionally referred to as *Component-Based Design.*[1059] The first of its design phases, the *conceptual design,* will result in a number of *usage scenarios,* which during the second phase, the *logical design,* are used to identify logical *business objects* and their related *services.*[1060] During *physical design,* the last phase of this method, the *business objects* and *services* that have been identified are mapped into physical *components,* which are the design abstractions that eventually will form the basis of an implementation.

In this method, a *services model* supporting three categories of *logical* services, viz. *user services, business services,* and *data services,* has been adopted. This *services model* differs from physically layered models, such as the well-known three-tiered and two-tiered client/server architectures, in that a logical service may reside in any physical layer and may invoke any other service irrespective of its physical abode. Logical services are assembled into logical subsystems, which are referred to as *business objects,* provided they have a business meaning. A *business object* may span more than one service tier, and it will not necessarily be implemented by a single physical component. On the contrary, a physical component may include many business objects, and during implementation one business object may be split into portions located in different components – typically one for each service category. The different service categories may be implemented by distinct tools, typically *Visual Basic* for the user tier, *Visual C++* for the business tier, and *SQL Server* for the database tier.

1.6.2 BUSINESS OBJECTS IN *RDS*

In *Microsoft* texts on the *Remote Data Service (RDS),* which is a *service component* being part of *Microsoft's* database access technology *ADO (ActiveX Data Objects),* the term *business object* is understood as a special kind of middleware component.[1061] *ADO* by itself provides support for direct data connections, i.e. two-tiered client/server architectures, whereas *RDS* adds support for data access through an intermediary, which may either be the middle tier of a three-tiered client/server application or, in case a web application is built, *Microsoft's Internet Information Server (IIS).* Such an *RDS* middle-tier is made up of *COM automation objects,* which are commonly referred to as *business objects.*[1062] As the lifetime of these *business objects* does not extend beyond a

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1057 [Vaug97] surveys *Microsoft's* client/server strategy briefly, and so does [Huss97], although from a *SQL Server* perspective. [Sess98a], [Kirt99], [Pers99a], [Chap00], [Sess00b], and [BBCE+00] provide more or less comprehensive treatments.

1058 See p. 114.

1059 This method is presented in [Micr97e], a part of *Microsoft Visual Basic 5.0 Enterprise Edition.* Cf. also [Geor95a] and [MT96]. A more comprehensive component-based analysis and design method is put forward in [AF98].

1060 In [MT96], a business object is said to be "a design abstraction, not a piece of code" and to "describe the behavior of real-world items in a formal way".

1061 Below p. 614 *ADO* and related *Microsoft* technologies are surveyed. [Bath98] describes *RDS* as implemented in version 2.0 of the *MDAC (Microsoft Data Access Components)* implementation of *ADO.* Other service components are the *Cursor Service,* the *Synchronization Service,* and the *Shape Service.* See [Micr97g] for an explanation of the rôles of these. *RDS* was originally referred to as *ADC (Advanced Data Connector).*

1062 Already [Geor95a], which predates *RDS/ADO,* suggested that *OLE Automation* objects may be used to implement *business objects.*

single method call, they may be executed inside *Microsoft Transaction Server* or the *COM+ Component Services* in order to reap the benefits of automatic transaction management, load balancing, connection, object, and thread pooling, etc. With the arrival of *ADO.NET,* the most recent incarnation of *ADO, RDS* has, however, become deprecated.[1063]

1.6.3 ROCKFORD LHOTKA'S *VISUAL BASIC* BUSINESS OBJECTS

In a comprehensive study entitled *Visual Basic 6 Business Objects*[1064]*,* Rockford Lhotka presents his own *Component-Based Scalable Logical Architecture (CSLA),* an interesting and well-thought-out approach to client/server development taking advantage of *Microsoft's* profuse tools and infrastructural technologies for the construction of middleware *business objects.* Although Lhotka uses *Visual Basic* as his sole implementation language, the *CSLA* methodology, being firmly based on the *COM* software component technology, may easily be adapted also to any other *COM* compliant programming language. Interestingly, Lhotka's client/server machinery comes quite close to that of Sims', although their understanding of what a *business object* is differs fundamentally.

Lhotka's conception of a *business object* combines our *real-world object* and *middleware object* interpretations, which is to say that his *business objects* correspond to real-world entities and have their abode in the intermediate region between the user interface and the database. Technically, these *business objects* are implemented by *Visual Basic* classes, which, however, at run-time appear as *ActiveX objects* (also known as *Automation* objects) and, thus, may be used not only from *Visual Basic* programmes, but from any *ActiveX client* (i.e. *Automation* client).[1065] Additionally, an *ActiveX object* may be implemented in any *ActiveX* capable language, including *Visual C++* and *Visual J++*. *ActiveX objects* will typically be packaged in an *ActiveX Component* (i.e. an *Automation server* or, in *Visual Basic* lingo, *code component),* which may either be an *in-process (DLL)* or an *out-of-process (EXE)* server. They may, however, also be part of an *ActiveX Control* or even an *ActiveX Document.*[1066]

The *CSLA* method assumes a conventional three-tier *logical* architecture, splitting an application into a *presentation,* a *business,* and a *data services tier.* The *business tier* is made up of *business objects,* which are accessed from the *presentation tier* and, in turn, access the *data services tier.* The *business objects* are identified through the analysis of *use cases* and should be implemented so as to hold all the functionality and business rules of an application. The tiers are kept strictly apart, so that it will be possible, for instance, to exchange a forms-based *Visual Basic* user interface for a *DHTML*-based web browser interface without modifying the *business* and *data services tiers.* The *presentation tier* is the client of the *business objects,* which, hence, do not contain or refer to presentation modules such as Sims' *view CBOs.*[1067]

In order to "keep processing as physically close to where it's needed as possible"[1068], the *business tier* is divided into two subtiers, one consisting of *UI-centric business objects* and another of *data-centric business objects,* and, consequently, each *business object* is split into a *UI-centric business object* and a *data-centric business object.* The former will typically hold data access methods and other methods frequently called by the *presentation tier,* whereas the latter will handle database-related operations, such as loading, saving, deletion, and business rules

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[1063] See [Shir02].

[1064] [Lhot98]. This is a revision of [Lhot97], *Professional Visual Basic 5.0 Business Objects.* See also [Lhot01] for some observations by Lhotka on business objects in *.NET.* Similar, but less substantial attempts to reconcile *business objects* in the "middleware objects" sense with *Visual Basic* development and *Microsoft's* infrastructural technologies are provided by, for example, [TMS97], [Gold98], [GG98], and [Sche02]. See also [Kirt99] p. 215 et seqq.

[1065] This *COM* basis makes Lhotka's understanding of an *object* different from that of traditional object-oriented programming in a number of important respects. Firstly, *implementation inheritance* is not supported by his objects, although *interface inheritance* and, thus, *polymorphism* are. Secondly, an object may provide multiple interfaces. Thirdly, objects do not expose methods and data, but *methods, properties,* and *events.* Cf. [Lhot98] p. 10 et seqq. and p. 30 et seqq.

[1066] [Lhot98] p. 22 et seqq. discusses the trade-offs involved.

[1067] [Lhot98] p. 120, however, considers the possibility of using the *DataFormat* objects of *Visual Basic 6.0* for the creation of *ActiveX DLLs* that contain objects capable of formatting the data of *business objects* for display.

[1068] [Lhot98] p. 59. Lhotka contrasts the rich, responsive *GUI* interface, which requires the business rules to be processed on the client, to an *OLTP*-oriented, thin-client batch interface, which lets all business rules processing be centralised, but lacks the interactivity of the *GUI* interface.

processing that requires multiple database accesses. The user interface will only interact with the *UI-centric business object,* which in turn will lean on the *data-centric business objects* for some operations. The latter, which may execute on the client machines, on the database server, or on a separate application server, possibly within *Microsoft Transaction Server* as *MTS* objects, will handle all interaction with the data sources, in most cases through an abstraction layer such as *Microsoft's ADO (ActiveX Data Objects).*[1069] Notably, the *UI-centric* and *data-centric business objects* correspond neatly to Sims' *model* and *entity CBOs*.

If *UI-centric* and *data-centric business objects* are kept physically apart, they will need to communicate through, for example, *DCOM*. Since frequent *DCOM* calls will deteriorate performance and, additionally, the use of numerous arguments in *DCOM* calls may imply considerable overhead, Lhotka recommends that the data of *business objects* be serialised and passed between *UI-centric* and *data-centric business objects* through a single argument of a single *DCOM* call.[1070]

The three *logical tiers* of an application may, according to Lhotka, be *physically distributed* over two, three, or four *physical tiers.*[1071] He discerns two different variants of the *2-tier physical architecture*, viz. *traditional 2-tier* (also known as *intelligent client* or *fat client design)* and *2-tier with centralized processing.* In the former variant, the *presentation* and *business tiers* are co-located on the client. In the latter design, the *business tier* is split and its *UI-centric business objects* are located on the client and its *data-centric business objects* on the database server so as to reduce network traffic and facilitate the use of disparate types of data sources.

The *3-tier physical architecture* adds an intermediate *application server,* which will hold the *data-centric business objects*. This architecture may be a good choice, in case much processing is done in the *business tier,* which tends to slow the database server down in a *2-tier with centralized processing* architecture. In addition, it may provide good scalability, if the load can be balanced over a number of *application servers*. This design will, however, increase the total amount of network traffic. Consequently, communication between the *application server* and the *database server* should take place over a high-speed channel (e.g. a cluster where the machines communicate through shared memory or a high-speed network) separated from the network through which clients connect to application servers.

Lhotka also discusses two kinds of *Internet architecture,* the one a 3-tier variant, the other a 4-tier one, which may be regarded as variations of the above 2-tier and 3-tier architectures, respectively. In both, the *presentation tier* is located inside a web browser and the *data services tier* on a database server. In the 3-tier variant, an *IIS (Internet Information Server) application*[1072] is co-located with the *UI-centric* and *data-centric business objects* on an intermediate *web server,* whereas in the 4-tier architecture the *data-centric business objects* are located on an *application server* separately from the *web server,* where the *IIS application* and *UI-centric objects* subsist.

1.6.4 CODA ON *MICROSOFT* TECHNOLOGY AS A BUSINESS OBJECT INFRASTRUCTURE

Microsoft's grand vision of software partly overlaps with that of Sims, but it also differs fundamentally from it by being based on the *machine/component metaphor* rather than Sims' *world/object metaphor*. The highly specialised interpretation of *business objects* present in some *Microsoft* documents seems limited and inadequate, at least when compared to Sims' *business object* vision, although the identification of *automation/ActiveX objects*

[1069] The interactions with the data sources may take place through a special *manager object,* effectively isolating the *business object* from the particulars of data access. These correspond to Sims' *resource CBOs*. See [Lhot98] p. 162 et seqq. for a discussion of how to handle persistence. Somewhat oddly, the possibility of using *RDS* is not considered.

[1070] [Lhot98] p. 121 et seqq. discusses the pros and cons of various *Visual Basic* constructs (including *user defined types (UDTs), Variant arrays, ADO Recordsets,* and *property bags),* which can be used for the serialisation of object data.

[1071] [Lhot98] p. 114 et seqq.

[1072] See [Lhot98] p. 595 et seqq. An *IIS application* consists of one or more server-side *WebClass* objects, which are compiled chunks of code written in *Visual Basic 6.0*. Additionally, *HTML* files are compiled into *WebItem* objects, which are used by the *WebClass* objects as templates for the creation of the *GUI HTML* code sent from *IIS* to the web browser. Instead of the *IIS application* technology, *Active Server Pages,* containing a mixture of *HTML* and *script* code written in *VBScript* or *JScript,* may be relied upon for the creation of the user interface. Another possibility is to create a *Visual Basic 6.0 DHTML* application, although such an application will only run in *Internet Explorer* on *Win32* platforms. See [Lhot98] p. 567 et seqq. If a web server other than *IIS* is used, the *IIS application* or *Active Server Pages* will, of course, have to be replaced with similar non-*Microsoft* technology.

with business objects suggested by the lingo of *RDS* pointed out a possible path of reconciliation of the *component* and *business object* concepts.

Lhotka virtuously has explored, developed, and generalised this idea of using *automation objects* as *business objects*. He does, however, not consider the possibility of going beyond the conventional middleware interpretation of *business objects* and does not seem to be aware of Sims' ideas on business objects, although he is generally very reticent on his sources of inspiration. Thus, his *business objects* lack some of the more alluring properties of Sims' *CBOs,* such as individual executability, loose coupling through semantic messaging, and the remarkable level of configurability characteristic of the *Newi CBOs*. Consequently, he overlooks pieces of *Microsoft* technology that may be useful for a richer business objects infrastructure, such as *ActiveX Designers* for user configurability and parts of *Microsoft's XML* technologies for semantic messaging, although he interestingly suggests the use of *Visual Basic's DataFormat* for the formatting of data for display. Strangely, he does not take *RDS* into account, which seems to have the potential of reducing the undesirable ripple effects that will haunt most multi-layered client/server designs, including Lhotka's.

In conclusion, *Microsoft's COM/ActiveX* and *.NET* technologies offer most promising, not to say the most promising, infrastructural foundations for a *business object facility,* although the task of engrafting *Newi*-style *business objects* upon such *component* infrastructures remains a path yet to be taken. In the chapter on realistic computing, I will give some suggestions about how this can be done.

1.7 A FEW FINAL WORDS

In the previous sections, the notion of a business object as well as the most significant attempts to implement this somewhat fuzzy concept in real-world technology have been subjected to a comprehensive scrutiny from a plethora of different viewpoints. In my contention, Oliver Sims' *business object* vision and its implementation in *Newi*, albeit widely neglected during its brief life-span and today almost completely forgotten, was the most promising outcome of the entire "business objects movement" and arguably also one of the more fascinating developments in software technology at large. Although the business objects movement now belongs to history, largely as a consequence of the stillbirth of the *BOMSIG/BODTF* effort, the problems it brought on the table most emphatically do not. On the contrary, one may argue that the issues it tried to address have since become much compounded and amplified by the triumphs of the traditionally object-oriented software development paradigm, the *Internet,* and complex, multi-layered client/server architectures. Additionally, all the current hoopla around *XML* and the notion of a "semantic web"[1073] may, perhaps, render Oliver Sims' ideas about semantic messaging ripe for reconsideration.

In the next section, I will attempt to outline and explore a somewhat novel agenda of computing, which I will call *realistic computing* and which essentially is an attempt to develop the ideas inherent in the *Newi* business objects system in various respects and address some of its shortcomings. I will not there focus on the semantic messaging issues, but rather consider some other aspects of the *Newi* business objects agenda and in particular how the *Newi* ideas about the computer as an "object paradise" may be taken advantage of in the development of 3-D user interface technology. In addition, I will subject the relationship between objects and components to detailed examination and try to apply the insights gained on *Newi*-style business objects.

2 REALISTIC COMPUTING

> *The protean nature of the computer is such that it can act like a machine or like a language to be shaped and exploited. It is a medium that can dynamically simulate the details of any other medium, including media that cannot exist physically. It is not a tool, although it can act like many tools. It is the first meta-medium, and as such it has degrees of freedom for representation and expression never before encountered and as yet barely investigated.*

[1073] See [BHL01] and [BH01]. Cf. also http://www.w3.org/2001/sw and http://www.semanticweb.org.

Alan Kay[1074]

From its infancy, the digital computer, slowly and jerkily, has evolved towards the dimly perceived goal of a microcosm that mirrors the outer world with ever-increasing realism through modelling and metaphor. In this chapter, I will suggest that this momentous impulse towards realism deserves to be hypostatised into an "agenda" of its own, ***realistic computing,*** which in it subsumes, integrates, and synthesises a plethora of tendencies, trends, and research directions that all – more or less unwittingly – point towards the same realistic end-point. The two cornerstones of realistic computing are *Newi*-style ***business objects*** and ***3-D virtual worlds,*** and I will argue that considerable effects of synergy may result from their unification. In the *Panopeus* project, I have attempted to lay a foundation for realistic computing by various enquiries, which, from different points of view, aim at clarifying and, if possible, resolving various issues pertaining to the technical side of this novel agenda. In a later chapter, I will consider the non-technical aspects of this endeavour and, in particular, the looming issue of its ethicality, deeper significance, and correlation to the Faustian spirit of Western modernity.

The digital computer was brought into existence by the wartime needs to perform complex calculations and crack ciphers, but it was soon recognised that its realm of relevance extends far beyond the computation of trajectories and logarithmic tables. The computer is indeed not just a calculating tool, but the provider of a ***universal noetic substance,*** the intellective matter of a "universe" or "microcosm" – or shall we say "microverse"– in its own right, and inside this digital microverse man has to take on the quasi-divine task of creating order out of a chaotic and unfathomably profuse multiplicity of potentialities. Unfortunately, to be divine is a difficult thing for mere mortals, and, hence, to figure out what scripts should be used on the binary *tabula rasa* puts the severest of strains on our frail and feckless mortal imagination.

Slowly, an intricate mosaic or netting of investigative and ideational *agendas* has nonetheless unfolded, nourishing and promulgating diverse conceptions of the nature and essence of computing and diverse visions and views of what to put onto the binary *tabula rasa.*[1075] The divergent veins of thought and mentality that we provisionally call agendas are not mutually exclusive, homogeneous insulae, but, just as they all issue from the single artery of the binary electronic calculator, they all proliferate into a skein of countless venules of sub-agendas and subgoals, which interrelate and interlace complexly through a fine tissue of capillary concepts, ideas, and thought-complexes. One agenda, the ancestor of all the others, sticks to the austere *Pythagorean* view of the computer as a logico-mathematical device and uses various flavours of mathematical ratiocination as its sole tool of understanding, interpretation, and research.[1076] Forthwith at the outset, the need to control the operation of the digital calculator germinated another forceful agenda, which transforms the computer into a linguistic prosthesis, a *Sprachmaschine*[1077] to be manœuvred through the sets of instructions and constructs of the terse, new-fangled synthetic idioms known as programming languages.[1078] Another agenda of long standing, related to the ones already mentioned, but fundamentally different in outlook, is that of *artificial intelligence,* which broached the view of the computer as a purveyor of human-like or even superhuman intelligence – po-

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1074 [Kay84] p. 47

1075 The term *agenda* is unencumbered by the grand and complex connotations of concepts such as Kuhn's *paradigm* or Lakatos' *research programme,* to both of which it at any rate is clearly and closely related (see [Kuhn70] and [Laka65]). See also [Heim93] p. 118 et seqq. for an interesting discussion of the significance of *visions* and [Coyn95a] p. 307 et seqq. for a treatment of various basic *metaphors* of computer systems, including the calculator, the drawing device, and intelligence. It should be noted that the original sense of *paradigm* (Greek **παρά-δειγμα**) is *example* and that the primary mechanism, by which agendas institute themselves, will be just through prototypical exemplars of different kinds. Cf. [Kuhn70] p. viii.

1076 The lasting vigour of the mathematical conception of the computer – in particular in academe – is borne out by the very designations *computer, ordinateur, Rechner,* and *computer science,* to say nothing of the way programmers are educated. It is interesting to note that in the Scandinavian languages broader terms like *dator* (Swedish), *datamat* (Danish), or *datamaskin(e)* (Swedish, Norwegian, Danish) very early ousted older concepts with mathematical connotations, such as *kalkylator, siffermaskin,* or *matematikmaskin.* Likewise, in Scandinavia computer science is referred to by designations such as *datalogi, datavetenskap,* or *informatik.* The term *dator* was coined by the Swedish computer pioneer Börje Langefors, whereas *datalogi* was invented by the Danish computer scientist Peter Naur. See [Bruh88] p. 91.

1077 This useful term of Heidegger's has been appropriated from [Heim93] p. 60 et seq., although I do not here accede to Heim's interpretation of it.

1078 [Heim93] p. 36 et seqq. discerns the first germ of the computer in Leibniz' notion of a universal symbolic language. This notion may be further traced back to the Spanish philosopher Ramon Lull, as is done in [Frän74]. See also below p. 478.

pularised by that curious pet idea of the 50s, the *electronic brain.*[1079] During the 60s, a plethora of new and vigorous agendas emerged, which came to play pivotal rôles in the further development of computing and still do so as much as ever. Among the most consequential of these beacons and foci of thought and activity – although by no means the only ones – were the agendas of man-computer interaction (Licklider's *man-computer symbiosis*[1080], Engelbart's *augmentation of man*[1081]*)*, textual connectionism (Nelson's complexly interconnected and annotated hypertextual *docuverse*[1082]*)*, geographical connectionism (realised through the *ARPANET, Internet, WWW,* etc.[1083]), and the industrialisation of software production *(software engineering*[1084]*, software components*[1085]*, software reuse*[1086]*).*

Another influential agenda that made its first appearance in the 60s was that of *object-orientation.*[1087] Its particular significance is that it hints at an escape from the protean dilemma of the binary *tabula rasa,* liberating us of our shortcomings as demiurges by suggesting that we simply mimic, *simulate,* the well-known outside world instead of flounderingly and vaingloriously trying to institute novel orders and novel arrangements orchestrated according to unfamiliar, new-fangled rules and laws, which have to be made up by ourselves. Herein object-orientation has taken up a truly pragmatic and conservative attitude – it embraces and refines what is known to be good and useful, but shuns experimenting with the unknown, the evils of which had better be left unexplored. Yet, its models, however subtle or complex, are of course only fickle shadows on the walls of Platonic caves, gleaming theatres of phantasms and metaphors, ridiculously simplifying the abysmal complexities of the external world, not arbitrarily, but in any way useful for whatever mundane purpose at hand. *Objects* and, in particular, *business objects* as described in the previous chapter are phantasmic actors on the digital stage, and there are divers strains of them, some of which, in spite of their apparent gifts and talents, are still little known and "as yet barely investigated".

It is my thesis that *object-orientation, business objects,* and various other developments and endeavours[1088] partake in a long-ranging thrust towards what I denominate *realistic computing*[1089]*,* the disposition of which unveils itself through the transformation of the computer into increasingly more realistic "mirror worlds"[1090] or "habitats"[1091]. *Realistic computing* attempts to thwart the protean predicament of computing by the pervasive and systematic use of real-world metaphor and real-world modelling as the tools and instigators of intelligibility and usability. Although numerous individuals, starting from very different vantage points, have for decades pursued the goals of *realistic computing,* neither its own pursuers, nor apprehensive observers of digital pursuits have very often been able to recognise the contours of the edifice about to take shape. Some men of parts or vivid imagination, more often science fiction novelists and "cranks" than computer scientists, did descry the pattern when it was still dim and evasive, but it is not until recently – almost as on a spur of sudden universal

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[1079] See [Turi50] and [Neum58]. [Heim93] p. 58 et seqq. brands the *AI* agenda the *computer as opponent* view and contrasts it to the *computer as component* view.

[1080] See [Lick60] and [Lick65].

[1081] See [Enge62] and [EE68].

[1082] See [Nels65], [Nels72], and [Nels92].

[1083] [Lick68]

[1084] [NR69]

[1085] [McIl68]

[1086] [Beme68]

[1087] [DN66]

[1088] These will include aspects of technology areas as disparate as software components, distributed objects, software agents, client/server and web technology, object-oriented and distributed databases, human-computer interaction, object-oriented and perceptual user interfaces, compound document management, natural language recognition and synthesis, computer gaming, virtual reality, and virtual worlds – and indubitably others as well.

[1089] *Realistic computing* is unrelated to Heim's *virtual realism,* which is a programme and a plea for a middle course between technooptimism and technopessimism, in particular with reference to virtual reality. See [Heim98] p. 33 et seqq. [Mano98] and [Gele91] p. 181 et seqq. provide two attempts at an analysis of the deeper significance of the urge for *digital realism* and *microcosms,* respectively. Cf. also [Coyn95a] p. 179 et seqq.

[1090] [Gele91]

[1091] [Wino97]

epiphany – that the plot seems to be about to become visible to all and sundry, as at last the nebular castle in the air, built by the visionaries and fantasists, is slowly crystallising into a new grand synthesis of computing. Two founding elements of this synthesis in gestation may, I suggest, be *business objects* and *3-D user interfaces,* the unification of which will conduce greatly to the transformation of computers into "realistic" pocket worlds.

1.2.1 BETTER BUSINESS OBJECTS

In the previous chapter, Oliver Sims' vision of *Cooperative Business Objects (CBOs)* and its implementation in the *Newi* system, from both of which, as frequently intimated before in this study, my own interest in *business objects* draws its main inspiration, was discussed at some length. The *CBOs* of *Newi* have a number of notable properties, which can be summarised in this way:

- *CBOs* are bona fide objects, supporting inheritance, polymorphism, encapsulation, etc., and represent real-world concepts, as e.g. "customer", "car", or "invoice".

- *CBOs* are independently executable and may have one or many associated views, through which they present themselves to the user. *CBOs* may be freely distributed across a network and support transparent persistence.

- *CBOs* communicate through messages, to which are attached *Semantic Data Streams,* i.e. argument lists, where a semantic tag and type information have been associated with each data item.[1092] The *CBO* receiving a message handles message dispatch by forwarding the package of data received either to one of its methods, which will then extract the information it needs through the semantic tags, or, alternatively, to its parent object.[1093]

- Almost everything in *Newi* is configurable: Inheritance hierarchies are, for example, assembled dynamically during execution according to configuration data, and also user interface views and code implementations are dynamically attached to the *CBOs*.

- *CBOs* may be written in almost any programming language, including non-OO ones.

In my view, *business objects* are primarily germane to the upper echelons of the hierarchy of software inside the computer and should be visible and manipulable in the user interface rather than buried in programme code and middleware, where their suitability can be questioned.[1094] In my treatment of the *Newi* vision, I pointed out some topics on which I think further work would be in place in order to refine and advance the *(Newi*-style) *business objects* paradigm, including[1095]:

- infrastructural foundation
- the messaging mechanism
- class fragility
- the user interface
- payment mechanisms
- client/server design considerations

[1092] A semantic data stream may typically look like this:

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[Name] <James Harris> [Balance] <250> (Int) [Age] <33> (Int)
```

This data stream contains the data items *Name, Balance,* and *Age* of the types *character* (default), *int,* and *int,* respectively.

[1093] This is referred to as *message-time binding,* a kind of very late binding.

[1094] See footnote 495 on p. 114 above and p. 257 et seq. below.

[1095] See above p. 173.

In a number of independent studies, the essence of which has been synthesised in this thesis, I have tried to address many, though not all, of these issues. Firstly, I have investigated and surveyed various distributed object and component technologies as well as the various building blocks of *Microsoft's* comprehensive *Internet* client/server architecture *DNA* in order to be able to evaluate the suitability of these technologies as candidate infrastructures for *business objects.*[1096] If the kind of loosely coupled business objects supported by *Newi* and providing the foundation of realistic computing are to gain widespread acceptance, they obviously need to be based on a less exotic infrastructure than *Newi.* Arguably, a *business object facility* would profit from being either built on top of or, better still, being integrated into a software component infrastructure, such as *COM/ActiveX* or *.NET.* As, however, the latter alternative is unlikely to happen presently, I will in a later section briefly contemplate what needs to be done in order to implement a *business object facility* on the basis of *Microsoft's COM/DNA* component infrastructure.

Furthermore, I have studied the problem of class fragility and ventured to suggest how it can be resolved,[1097] and I have also looked into various developments in user interface technology and attempted to understand how they fit together and impinge on the *business object* vision[1098]. In particular, I have argued that *Newi*-style *business objects* and 3-D user interfaces may be felicitously combined so as to form the foundation of *realistic computing.* Whereas much of the background matter has already been covered in the previous chapters or can be found in the appendix on networked components, some of the results and conclusions arrived at in these investigations will be presented below. Currently, these proposals are all at the blueprint stage and have not been tested in actual implementations for reasons that will be explained in the final chapter of the present work. The epicentre around which they revolve is the "realistic" idea that *business object, component,* and *virtual reality* infrastructures will ultimately coalesce and that the two latter will constitute the foundation on which the former will be built.

1.2.2 THE PANOPEUS APPROACH TO REALISTIC COMPUTING

Above, I hinted at an understanding of the digital computer as a provider of a *universal noetic substance,* a novel kind of meta-matter, or, as it were, binary clay, from which all kinds of intellective artefacts and structures may be built.[1099] In the *Panopeus project,* which borrows its outlandish name from the Greek town of Panopeus, where, according to the ancients, the first human beings were formed out of clay by Prometheus and subsequently inspirited by the breath of the goddess Pallas Athena, I have tried to explore and cast light on the agenda of *realistic computing* in various ways. In this undertaking, a fittingly *Promethean attitude* was espoused, manifesting itself in two distinct ways.

Firstly, just as Prometheus used the extant Panopean clay to form the first humans beings, but did not vouchsafe to dabble in the fabrication and mixture of this clay *per se,* I have found it advisable to utilise, as far as possible, the infrastructural clay at hand in today's personal computers, their operating systems and *APIs,* component and distributed object technologies, programme development environments, 3-D display software, etc. as a premise and a starting-point for the task to which I have been primarily committed, i.e. the investigation of how computer-based microcosms can be built from 3-D business objects. Whereas the interest in distributed object, component, user interface, and 3-D graphics technology is currently very strong, all these fields tend to subsist in splendid isolation from each other as discrete areas of concern and research and, thus, only little work has been done in order to combine and synthesise them, apparently largely owing to the lack of a clear unifying vision, such as the agenda of *realistic computing* outlined in this thesis. Significantly, I have striven to position the Panopeus project not in the intersection, but on the shoulders of these technologies,

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1096 [Pers97] and [Pers99a]

1097 [Pers99d]

1098 [Pers00a] and [Pers99c]

1099 The emergence in the 1940s of the digital computer as a provider of a *universal noetic substance* was strikingly paralleled by the simultaneous appearance of plastic as a *universal hylic substance,* from which all kinds of material artefacts could be created. The arrival of such universal substances seems to demarcate a new triumphantly "scientific" phase of industrialism, where the substances given by nature and used by convention are slighted in preference of synthetic man-shaped matter and meta-matter, plastic and digital meta-plastic. If the proponents of *nanotechnology* are successful in their strivings to make matter directly programmable, artificial matter and meta-matter may eventually be unified into what seems to be the utmost corollary of this programme of universal synthetics. See, for example, [Drex86] and [Cran96]. Cf. also below p. 490.

wishing to take advantage of and instil life into them by focusing on functionality, usability, interaction, and appearance rather than on infrastructural viscera, although some mechanisms supplemental to the infrastructure at hand will patently have to be devised in order to make the contemplated vision come to life.

Secondly, the *Panopeus* project can be construed as part of a much larger Promethean plot of snatching the fire from computing's expert gods and giving it away to its mortal users. This plot is staged by multiple developments and trends, including not only the technological advances presupposed by the agenda of *realistic computing* (such as loosely coupled 3-D business objects and tools for end-user assembly, configuration, and scripting of these), but also strong economical (expert-driven software development being costly and fraught with difficulties and risks) and socio-organisational (users growing increasingly computer-knowledgeable, independent, and responsible[1100] and organisations becoming increasingly agile, virtualised, and decentralised[1101]) driving forces.[1102]

Taking up and starting out from this doubly *Promethean attitude,* we may outline the *Panopeus* approach to *realistic computing* by the list of highlights given below:

Component-based business objects. In my contention, large-grained, thing-like, loosely coupled, *Newi*-style business objects provide a most promising alternative to the problematic and much-scolded "traditional application" as the focal points of user activity and attention in an interactive computing environment. Furthermore, it seems clear that business objects should be built on top of a distributed objects/component infrastructure, such as *Microsoft's COM (Component Object Model)* and *DNA (Distributed interNet Architecture),* the same company's *.NET, Sun's Java* technologies, or *OMG's CORBA (Common Object Request Broker Architecture),* supplemented by as thin a layer as possible of business objects-specific infrastructural support functionality.[1103]

Semantic messaging. Semantic messaging is the nugget of gold, by means of which *Newi* bestows on its business objects such lustrous benefits as loose coupling, ad hoc interoperability, nay, co-operability, and resilience to change. The recent upsurge in interest in *XML*-based semantic tagging has made *XML* the natural candidate for most semantic messaging purposes.

Rapport. In current computer interfaces and environments, human-object as well as object-object interactions appear very impoverished and inadequate when compared to the rich interactions taking place in the real world. It would be desirable to enrich the interaction capabilities between business objects through the concept of *rapport,* a kind of temporary, visual, directly manipulable channel set up by a user in order to make two or more business objects communicate, one of which may be the user's own avatar.[1104]

1100 [Druc68] is the seminal work on the long-standing trend from *production work* to *knowledge work,* whereas [Lévy97] p. 31 et seqq. contends that we are currently witnessing the automation also of knowledge work and that the economy of the future will be focused on "the production of the social bond, the relational". See footnote 553 on p. 125 above.

1101 See [Lévy98] and [DM92].

1102 The principle framed in [Gabr96] p. 112, that successful programming languages must not demand "mathematical sophistication" of their users, is at least as applicable to object systems intended for end-user manipulation and may be used as an argument against expert-oriented environments such as *Smalltalk* as a basis for a homogeneous multi-layered "object paradise". Insofar as the upper levels of Cox' hierarchy – discussed in the section that starts on p. 42 above – are the realms of end-users, their objects must, in our view, differ essentially from those at the lower levels.

1103 The thickness of this layer clearly depends on which infrastructure is opted for. In the *Panopeus* project, my penchant was towards *Microsoft's COM/DNA.* For a discussion of the trade-offs involved, see p. 536.

1104 *Rapport* between objects may take place through a *socket,* by which term I signify a kind of flexible, user-manipulable analogue of the reference of programming languages. A *socket* is essentially a named variable, to which an object sends messages. The *socket* may be either *single-valued* or *multi-valued,* depending on whether it is capable of holding more than one reference to other objects. It is legal to send messages to a *socket* that currently holds no references to other objects at all.

Sockets are somewhat similar to the *outgoing* or *required interfaces* of *module interconnection languages (MILs),* although the circumstance that our business objects use semantic messaging for interconnection rather than typed, positional call interfaces also make them very different from these. [PN86] provides a survey of *module interconnection languages*. Declarations of required interfaces form the basis of "plug and socket" architectures such as that of the *Rapide* language described in [LV95] and [LVM95]. The first *MIL* was devised by DeRemer and Kron (see [DK76]) in order to facilitate the activity of "programming-in-the-large", i.e. the knitting together of programme modules into large systems.

Janus-faced business objects. The success of *Wintel*-based personal computing is doubtless largely the consequence of the success of the components- and forms-based programming paradigm for which *Visual Basic* and the successive *VBX, OCX, ActiveX,* and *.NET* technologies provide the archetypal paragon. In addition to *card-level* loose coupling through *XML*-based semantic messaging, I thus believe that business objects should support the somewhat tighter coupling of *chip-level* component integration, thereby recognising the importance of the forms-based style of programming as a middle course between low-level systems programming and high-level (end-user) scripting and configuration.[1105]

Encapsulated Programming. Implementation inheritance, albeit a flexible and useful extension mechanism widely held to be the prime characteristic of object-orientation[1106], has during the 90s come under increasing fire as the purported source of miscellaneous woes, of which the most significant will be the so-called *fragile base class* problem.[1107] In the *Panopeus* project, I have developed the principles of "encapsulated programming", which attempts to eschew the class fragility problems by putting some restrictions on the inheritance mechanism.

3-D Object-Oriented User Interface (3DOOUI).[1108] Business objects make sense only in a truly object-oriented user environment. In particular, loosely coupled *Newi*-style *business objects* dovetail remarkably with 3-D user interfaces, which tend to be inherently object-oriented and loosely coupled, as shown by, for example, *Microsoft's V-Worlds,* which is an interesting virtual reality platform that will be somewhat more closely examined below.[1109]

Humbleness. Whereas there has been much excitement over the future prospects of web-based[1110] or *immersive*[1111] *virtual reality (VR)* systems, these technologies are today still saddled with bandwidth, equipment, cost, and other problems. A more humble approach than immersive VR, variously referred to as *desktop virtual reality* or *nonimmersive virtual reality,* dispenses with the fancy equipment altogether and instead attempts to visually convey the impression of a virtual world through the screen of an ordinary workstation, possibly supplemented by some other conventional output devices such as the loudspeakers of the computer for sound or a joystick for force-feedback. Not to get bogged down in problems of little bearing on my area of concern or incur costs defrayable only by very large and wealthy research organisations, I have focused my attention on a humble non-web, desktop VR environment, although the *Panopeus* approach can, I submit, easily be generalised to web-enabled and/or immersive VR environments as well, at least when these technologies have become less untoward and expensive than today.

Personal computing. Many advocates of novel computing paradigms, such as web-centric computing, virtual reality, ubiquitous computing, or information appliances, have predicted the imminent demise of the *personal computer.* For my part I believe that the prospects of the personal computer are excellent and that the idea of *one* strictly *personal,* general-purpose computing tool will retain its attraction for many years to come. However, this personal computer is likely to go through many transformations and, in particular, its form factor may eventually shrink into pocketsize and smaller. It is not difficult to extrapolate how this future *pocket PC* may be connected to different I/O devices in order to adapt to the user's current needs: *Stationary* equipment, such as keyboards, mice, and monitors, will most probably still be preferred when the computer is used for extended periods of time, whereas *wearable* or *notepad-style* devices will be employed when we travel around or attend

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1105 For a discussion of the terms "card-level" and "chip-level", see above p. 42.

1106 So [Wegn87] p. 169.

1107 See p. 232 below.

1108 The phrase *object-based* or *object-oriented user interface* is commonly used to signify a graphical user interface, where the user interacts with on-screen objects by performing direct-manipulation operations on them. See footnote 574 on p. 128 above.

1109 See p. 282 below.

1110 See p. 276 below.

1111 *Immersive virtual reality* systems require more or less costly and exotic equipment such as head-mounted displays *(HMDs),* data gloves, video cameras, video projectors, bodysuits, caves, etc. in order to create a sense of *immersion* into the virtual reality. Such systems may, for example, be utilised in simulators of different kinds, for entertainment purposes, or in order to achieve *telepresence* in dangerous or otherwise inaccessible environments. See below p. 268.

meetings. This personal device will also remain our preferred interface to the web, other networks, and the ubiquitous intelligent equipment of the future.

Client/server architecture. Distribution and shared persistence are the Achilles heels of object-orientation, which menace to make any object paradiso transmute into an object inferno, in particular when relational databases and transactioned database accesses are involved. This area obviously calls for careful study, forethought, and experimentation. Unfortunately, time did not allow us to delve deeply into these problems.

Business-orientation. As we accept Brad Cox' thesis that the lack of rational ways to do business with software components is the root of the software crisis[1112] and as it seems befitting to be able to do *business* with *business objects*, the consideration of object payment mechanisms also was part of the Panopeus agenda.

[1112] See above p. 36.

1.1 INFRASTRUCTURE FOUNDATION

In the previous chapter, I provided a lengthy account of the *Newi* technology, the primary starting-point for my own ideas about "realistic computing".[1113] However, *Newi* was essentially a proprietary technology – for instance, it acted as its own object request broker –, and, as evidenced by the course of events, *SSA,* the company that acquired *Newi* in the mid-90s, was not influential enough to set a business object *de facto* standard on its own. In order to garner wide support and acceptance, *Newi*-style business objects must obviously be founded on a less exotic infrastructure than *Newi.* Business objects may be understood as a special kind of loosely coupled, large-grained components, or even as ***ultimate components***[1114], and, hence, it seems reasonable to use a commercial component infrastructure as their foundation, which is to say that *CORBA,* the *Java/JavaBeans* technology complex, and *Microsoft's COM/DNA* or *.NET* will be candidates worthy of consideration in this context. Additionally, the tasks that must be addressed by a *business object* infrastructure are strikingly similar to those provided by commercial component technologies.[1115] Hence, I carried out a rather detailed study of *Microsoft's COM/DNA* in 1998-99 in order to assess its suitability as a business object infrastructure. This study has been added to the present thesis as a separate appendix and provides important background material to the current section.[1116]

The *SSA BOF* submission was an attempt to establish a *business object* infrastructure on a *CORBA* basis, although it did not succeed in gaining wide support within *OMG* and its *BOMSIG/BODTF* committee. As a consequence of the demise of the *OMG* sanctioned *OpenDoc* component technology, *OMG* lacks support for user interface components – notably, the *CORBAcomponents* specification is specifically geared towards middleware componentry.[1117] In any case, components, at least currently, seem to be of only marginal importance in the *CORBA* effort, which rather is focused on middleware and, in particular, cross-machine and cross-platform object communication. In the typical behind-the-scenes vein of *CORBA,* neither the *OMG business object* endeavour, nor the *SSA* submission was concerned with the user interface aspects of *business objects.* Additionally, the still spotty support for essential *CORBAservices* and other *OMG* specifications in commercial *CORBA* products, the debacle of the *BODTF business object* effort*,* the lukewarm market response to the *CORBA* technologies, the wavering enthusiasm for the *OMG* endeavour also among the most stalwart backers of *CORBA,* such as *IBM* and *Sun,* and the subsequent stampede of these stalwarts to *Java* technology are factors that must give those who consider *CORBA* a potential foundation of a *business object* infrastructure pause.

On the other hand, a *Java*-based infrastructure might ride on the current wave of *Java* enthusiasm and would possibly ease the adaptation of *business objects* to the *Internet* at that, although such an infrastructure would have to give up on language independence. Additionally, *JVM*-based byte code interpretation in combination with the possibility to pass objects by value through *RMI* would facilitate the transmutation of *business objects* into *mobile agents.* Although *JavaBeans* does not presently provide full support for *compound documents*, it

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[1113] See p. 142 et seqq.

[1114] Cf. supra p. 116.

[1115] These tasks were mentioned on p. 158:

- semantic message handling and routing, including support for conversations, *serial re-usability*, marshalling, etc.
- thread and concurrency management
- network communication and routing
- object loading and initialisation
- object persistence
- various aspects of object management including the handling of class hierarchies
- naming, event, transaction, and relationship handling
- memory management and garbage collection

Of the above features, serial reusability (including automated thread and concurrency management in accordance with the *synchronous non-blocking messaging* model) and *Newi*-style dynamic inheritance are the only features not directly provided for by commercial component technologies. Notably, it would be preferable if semantic messaging could be supplied through the growing infrastructural support for *XML*. Cf. [KJ98] p. 115 et seqq. for a discussion of "agent-enabling infrastructures", including *OpenDoc, OLE/ActiveX, CORBA,* and *DCE.*

[1116] See below p. 535.

[1117] See [OMG02b], [OH98] p. 831 et seqq., and [Hoqu98] p. 487 et seqq.

does offer some of the same *GUI* advantages as *OLE/ActiveX* and *.NET*. There is also an interesting possibility to combine *Java* technology with *CORBA* or *COM*. Unfortunately, large parts of the *Java* enterprise infrastructure needed for business objects, such as *Enterprise JavaBeans,* are either still in gestation or immature. As with *CORBA* products, *EJB* and other enterprise *Java* products tend to be expensive, incomplete, fraught with proprietary solutions, and very difficult to combine with products from other suppliers. Additionally, both *CORBA* and *Java* are basically object-oriented rather than component-oriented, and the support for components they offer appear more as an afterthought than their sap and lifeblood, so if we believe that components are the essential underpinnings for a *business object facility,* we should probably cast about for something more suitable.

Doubtless, an implementation along the same lines as the *CORBA* one proposed in the *SSA BOF* submission would be feasible also on top of *COM* or *.NET* and the various related *Microsoft* technologies.[1118] Additionally, the *GUI* orientation of the *ActiveX* and *.NET* component technology should prove very useful for *business objects* and make it easy to spiff up their appearances to the current state-of-the-art in *GUI* technology. Functionality, such as drag and drop, compound documents, and scripting, may be put to good use in business objects. To combine *business objects* with visual component technology in order to create *Janus-faced,* hybrid "business object components", thereby facilitating the utilisation of business objects also from visual *RAD* environments, such as *Visual Basic,* would make *business object* technology more palatable to large categories of programmers. Unfortunately, such benefits would probably only be reaped at the cost of some of the conceptual integrity of *business objects per se*. The paramount advantages of *COM/DNA* or *.NET* as a foundation of a *business object* infrastructure will, however, be 1) that they actually exist, 2) that their unity is ensured by a one-vendor implementation, and 3) that their vital parts have been proven through widespread use for considerable time.[1119] Importantly, they include support for most of the features needed by a *business object* infrastructure, and in this respect *Microsoft* undoubtedly has a lead that will be very difficult to leapfrog for competing technologies. In addition, reliance on *Microsoft* technology may make it possible to take advantage of a wide assortment of component-based *RAD* tools, existing technologies for easy user interface *(ActiveX Designers)* and database *(ADO)* configurability, simplified construction of multi-tier solutions *(RDS),* and extensive support for *Internet* programming. On the downside are the widely apprehended complexity of the *Microsoft* technologies and its at best incomplete provisions for platforms other than *Wintel.*

An attempt to build a *Newi*-style *BOF* on top of an existing component technology may either follow a "svelte" or a "turriculate" strategy. The *svelte strategy* would imply that the *BOF* is kept on a diet and that as much functionality as possible is relegated to the component infrastructure, thereby minimising the customers' dependencies on third-party infrastructure products. Ideally, the component infrastructure would itself provide all the support needed for *business objects,* reducing the *business objects* vision into a set of design guidelines. The *SSA* tagged data submission could be viewed as an attempt to provide such a svelte *BOF* within a *CORBA* framework, or, alternatively, to transform *CORBA* into a rudimentary *business object* facility. The difficulty with this approach lies mainly with the technological complexity of today's commercial component technologies, which are known to have very steep learning curves that will put off many, if not most, business programmers. Furthermore, the visions behind software components and *business objects* are quite different, and there is an obvious risk that an attempt to amalgamate the two may result in conceptual clashes.

The *turriculate strategy* involves the framing of a self-contained *business object* layer on top of the component infrastructure in order to shield the *business object* programmer from the complexities of infrastructure programming and present him with a homogeneous *business object*-oriented view of the world. The turriculate approach is well exemplified by the *SSA business object* submission, where, for instance, *CORBAservices* have been masqueraded as *XOs*. Although conceptually this approach will unquestionably come out much more satisfactory than the *svelte* variant, it may entail a major development effort, inasmuch as *business objects* need rich and complex infrastructure support.[1120] At that, the technologies that result from such an effort will only have a chance to gain widespread acceptance if they are supported by major market players.

[1118] Notably, asynchronous calls are supported in both *DCOM* and *.NET*. See 604 and p. 611 below. Cf. also [Plat99] p. 115 et seqq.

[1119] The last benefit will apply primarily to the *COM/DNA* technology, whereas *.NET* still is a new and less proven technology at the present.

[1120] They are at least as demanding as the *supercomponents* mentioned in footnote 507 on p. 116.

1.2.3 THE MESSAGING MECHANISM

Through *semantic messaging* Oliver Sims bestowed on his business objects the benefits of loose coupling, ad hoc interoperability, and an unusual degree of resilience to change. There is, of course, a price to be paid for these boons. Demurrers that might be put in against semantic messaging include:

- The programmer has to write his own dispatch code and has to pack and unpack data from semantic data objects – awkward chores that make for code turgidity.[1121]
- Efficiency concerns may be raised not only about messaging as an *IPC* mechanism, but also about the overhead induced by the administration of the dispatch and *SDS* packing/unpacking operations – at least if the alternative would be simple, direct procedure calls.[1122] It should, however, be kept in mind that since the *granularity* and *coherency* of well-designed *CBOs* may be expected to be high, the potentially slow *CBO* interactions will not occur very frequently and mainly during user and database interactions, which are operations that will be at least an order of magnitude slower than method calls anyway.
- Although this is about to change through the rapid ascent of the *XML* mark-up format and *message-oriented middleware (MOM),* such as *Microsoft's MSMQ,* semantic messaging remains a somewhat exotic interconnection mechanism, at best playing a subordinate rôle in the major commercial component technologies.[1123] In order to pass beyond their current very sequestered niche, *cooperative business objects* probably will have to learn to play the rôles of a *component* as understood in these technologies. This will entail support for standard component interaction mechanisms – be it in addition to or instead of semantic messaging.

As a remedy against the need for excessive coding, Eeles and Sims suggested a code generation scheme, which, however, implied that the loose coupling between business objects would have to be forgone – and with it most of the benefits promised in the business objects vision.[1124] Alternatively, the torrents of message loop code may be staunched by the prudent use of the reflective[1125] and dynamic invocation capabilities of current component technologies – the *COM* dispatch interfaces, the *dynamic invocation interfaces* of *CORBA*, or the reflection services of *Java* and *.NET*[1126] – so as to have the business object infrastructure do the dispatch dynamically. This would imply that the infrastructure would not just forward the message to its addressee, but

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[1121] Although event/message loop programming is the foundation of *GUI* programming (for a classical description of *Windows* message loop programming, see [Petz90] p. 15 et seqq. or [Petz99] p. 41 et seqq.), there has been a marked shift away from this programming model – modern *GUI* tools generally spare the programmer the drudgery of doing dispatch by hand and instead distribute events directly to the widgets. For example, *Microsoft's* first-generation visual components, the *VBX* controls, were managed through message loop programming, which was considered so cumbersome – and inefficient – that it was abandoned in the next-generation *OCX/ActiveX* controls.

[1122] Performance is of course also dependent on the underlying communications protocol.

[1123] Important messaging-based interconnection technologies include *message-oriented middleware (MOM,* also referred to as *message queuing* or *queued messaging middleware* – see [OHE96a] p. 125 et seqq., [SE98] p. 123 et seq., [Sess98a] p. 443 et seqq., [Dick98], and p. 590 et seqq. below) and various inter-agent messaging techniques. Currently, neither of these can, however, be considered as real mainstream technology, although the inclusion of messaging mechanisms in *COM+, Java,* and *CORBA* may eventually make for a change; cf. [Plat99] p. 115 et seqq. The *GUI* message loop, although fundamental in most *GUI* systems, is nowadays mostly concealed from the *GUI* programmer inside class libraries or visual tools. Consequently, only few programmers have direct experience of *GUI* message loop programming.

In contrast, tagging of data has become truly mainstream through the popularity of *HTML (Hypertext Markup Language* – for a description see, for example, [MK98]) for web page design. More advanced tagging languages, such as *XML (eXtensible Markup Language),* offer new possibilities on the web as recounted in [MFDG98]. *SGML (Standard Generalized Markup Language,* see [ISO86]) is a very flexible metalanguage intended for the definition of tagging languages such as *HTML,* which actually is a set of *SGML* defined tags, but is currently mainly used in advanced document management systems. *XML* is based on *SGML* and will support some of its extensibility and flexibility, while also reducing the complexity that has held back the dissemination of *SGML* to wider circles. Interestingly, in the *SSA* tagged data submission (see [SSA98a] p. 3-39 et seqq.) *XML* was used for the "stringified" representation of tagged data objects. Another important technology based on tagging is *EDI (Electronic Data Interchange).* See below p. 562 for a brief survey of *XML* and its applications, whereas more detailed accounts of *XML* can be found in numerous books, such as [Brad98] or [GP02].

[1124] [ES98] 230 et seqq. See footnote 746 on p. 156 supra.

[1125] [KRB91] p. 9 make a distinction between *introspective* reflection, which makes it possible to analyse a programme or object at run-time, and *intercessive* reflection, which may be used to change the behaviour of an executing programme. Here we are only concerned with the considerably simpler *introspective* variant.

[1126] Cf. [Szyp98a] p. 159 et seqq.

intercept it, and, by matching the semantic tags in the message with reflective information exposed by the recipient business object, infer which method to call and which arguments to pass.[1127] It might also perform any necessary type checks and type conversions. This done, it would invoke the proper method on the business object with the proper arguments. In this way, the infrastructure would act as a flexible adapter translating semantic messages into function invocations through dynamic method dispatch.[1128]

What would the benefits of this approach be? Well, firstly it would make the world of *co-operative business objects* coalesce with that of established commercial component technologies – without having to expose duplicate interfaces and without compromising the strengths of either technology noticeably. As soon as the mapping between a set of semantic tags and the function and argument names of a component have been established, the *component* will be available as a *business object,* which may be accessed through semantic messaging, participate in dynamic inheritance relations, and execute as a standalone piece of software. By the same token, a *business object* that implements the proper component interfaces may play the rôle of a certain type of component. Thus, a *business object,* in addition to *Newi*-style independent execution, may be endowed with the capability of more tightly knit interactions. For instance, it may act as an *ActiveX* control on a *Visual Basic* form or on a web page, or it may take part in an *OLE* compound document scenario, provided it implements the appropriate *COM* interfaces. The infrastructure may even support different component models and act as glue between components of different types, such as *ActiveX* controls and *JavaBeans*. Furthermore, the programmer will be liberated of the dreary and error-prone task of coding dispatch loops, as dispatch handling will be relegated from the programmer's domain of responsibility to the infrastructure.

Unfortunately, this approach is not wholly problem-free either, although most of the cumbers might be alleviated by the application of suitable palliatives:

- *Multiple entries.* The suggested approach implies that there will be more than a single entry into a *CBO,* which may cause problems for some less usual languages like *IBM's REXX.*[1129] This is obviously a minor complaint – except, perhaps, for the kith and kin of programmers working with such languages. Let us hope that all languages one day will support multiple entries!
- *Lacking support for semantic metadata.* As current reflection mechanisms do not support semantic tags, some kind of mapping between tags and method and argument names is needed. A configuration file or mapping database may fix this, although somewhat ineptly and at the cost of extra work on the account of the *business object* programmer. Additionally, the reliance on such a mapping file/database, used by the reflective infrastructure mechanism for the translation of a semantic message into a method call, introduces the possibility of errors that may be hard to spot. However, until the real McCoy of a standardised combined semantic and syntactic repository arrives, these drawbacks may still be bearable.
- *Performance.* Performance will remain a concern, since dynamic invocation mechanisms are not known to excel in this respect. As pointed out above, in practice the granularity and coherency of business objects may often bring the performance issues to naught. Additionally, various optimisation techniques may amend the problems somewhat.[1130]

[1127] Often, what we really want to pass from the sender to the receiver, is a *semantic data object*. This will, for instance, be the case when the arguments of the target operation cannot be determined beforehand. A typical example is the *Query* operation, which is supposed to return the values of the attributes specified by the list of names passed to it. Here, both the list of attribute names and the list of attribute values must be passed in a *semantic data object*. Hence, the infrastructure is required to support exchange of semantic data objects. It may even be contended that *semantic data objects* will be the natural way to exchange arguments in a *semantic messaging* system and that the support for other kinds of arguments is to be regarded as a compromise and concession to the current habits of commercial component technologies.

[1128] The proposed approach is similar to the one described in [OH98] p. 700 for mapping events into method invocations on a *Java bean* – although it has not been inspired by it. A similar approach is also taken in *interface engines* and *message brokers*. See below p. 596 et seqq.

[1129] See above p. 148.

[1130] Caching of reflective data is one optimisation that comes to mind immediately. Many optimisations used in languages that do dynamic dispatch – such as those utilised in the implementation of *Self* discussed in [USCH92] and [HCU91] – will not be useful in an infrastructure, which acts as a switchboard between self-contained, mostly compiled programmes and, thus, is incapable of performing such tricks as, for instance, dynamic compilation.

- *Reduced control of dispatch.* By relegating dispatch to the infrastructure we will have to give up control over the details of the dispatch process – it will, for example, no longer be possible to control method combination with superclass methods programmatically.[1131] However, control over the dispatch process could instead be exercised through configuration options, perhaps in the entries being part of the aforementioned semantic mapping file/database.
- *Conceptual clash of messaging and invocation.* In order to avoid introducing inter-*CBO* dependencies by the use of structured syntactic interfaces, it seems that the sender of a semantic message will still have to insert data into an *SDO* and send it off as a semantic message, although from the point of view of the receiver this message will look like a remote method invocation. Consequently, in a typical semantic messaging scenario there will be a noticeable discrepancy between the conceptual model of the sender and that of the receiver. This discrepancy may be reduced in a number of ways. Since the infrastructure *APIs* will probably be packaged as a *C* library in order to make them available to as wide a range of languages as possible, it might, for example, be expedient to have the ***send/post*** routines use the ***variadic*** argument lists of *C*[1132] together with semantic and data type tagging of the arguments so as to get rid of the anomalous and irksome packaging of data into semantic data objects. Whilst this approach would make the conceptual models of sender and receiver somewhat more uniform, no syntactic coupling between them would be introduced beyond the purely semantic one. The remaining conceptual clash between message sending and method invocation may not be entirely undiscernible, but as the old adage has it, you cannot eat the cake and still have it!
- *Loss of simplicity and conceptual integrity.* Putting *business objects* on the footing of today's very complex component infrastructures will unfortunately imply at least some loss in the simplicity and conceptual integrity inherent in a pure business object infrastructure, such as *Newi.* Beyond peradventure of a doubt, this loss is the most difficult problem with the proposed approach. The degree, to which it can be countered, is largely a consequence of the choice between the *turriculate* and the *svelte* strategy as explained above.

Of course, it would also be possible to reject semantic messaging altogether and rely exclusively on reflection to loosen the coupling between business objects.[1133] If the introspective mechanisms were extended by support for semantic information, this might well turn out to be quite an attractive alternative. The programming of such reflective interactions will, however, be at least as messy and prone to code bloat as that of interaction based on semantic messaging – and performance may well become worse at that. If this course is taken, much of the bulky dispatch code is actually moved from the receiver to the sender, whereas in the approach discussed above, it is entirely removed from the programmer's realm into the infrastructure, where it arguably belongs.

[1131] For a discussion of method combination, see supra p. 148.

[1132] As a consequence of their having been repeatedly denounced for maladroitly circumventing type controls, variadic argument lists have gone out of vogue. However, a few variadic *C* standard library functions, such as ***printf*** and ***scanf,*** have remained popular. See [KR88] p. 155 et seq. and p. 254. Some typical criticisms are voiced in [Stro97a] p. 154 et seqq.

[1133] Alternatively, it could be argued that the standardisation of domain interfaces would reduce the need for loose coupling more fundamentally. If objects are coupled through interfaces that accord with a standard, the coupling will be less prone to change and, thus, also considerably less harmful than otherwise. Standard interfaces may also facilitate ***ad hoc*** interoperability, at least within certain bounds.

Against such a seductive line of argument, one will want to object that there seems to be a distinct historical movement from static, strongly coupled, tightly knit, closed software systems towards more dynamic, loosely coupled, flexible, and open ones – and that this movement is not without reason. Additionally, standardisation is not only beneficial, but a ***sine qua non,*** if interoperability is to be achieved. However, it should in my view primarily concern semantics, not the specification of detailed syntactical interfaces that sooner or later are bound either to become grisly Procrustean beds, hopelessly and haplessly hampering necessary development and change, or to be overthrown by the staggering and constantly altering complexities of real-world requirements. To standardise call interfaces is much like creating a language that consists of only complete sentences as its building-blocks – although at times set phrases may come in handy, a living and useful language needs more flexible constituents that may be mingled and mixed freely and kaleidoscopically in order to express and adapt to the ever-changing whims and fancies of human nature and creativity.

Business objects will also need to expose outgoing (event) interfaces, which make it possible to register interest in events that originate in the object.[1134] When such an event occurs, the source *business object* will be responsible for sending an event notification – synchronously or asynchronously – to each object that has registered interest with it for this particular event. Event producers and consumers may be further decoupled through a system component, such as the *event channel* of the *CORBA* event service specification.[1135] An event channel lets consumers register interest in events of a certain type without having any direct knowledge of the event producers. A business object infrastructure should provide support for event handling – the *SSA XO*-based event service discussed above offers an attractive example of how this may be done. The paramount importance of event mechanisms can be appreciated by considering their rôle in forms-based tools such as *Visual Basic*. When programming in such a tool, most of the programme code will be located in *event handlers* associated with the various visual components out of which the forms-based user interface is built.

[1134] [SG96] p. 20 et seqq. and [BCK98] p. 101 et seq. treat *event systems* as a distinct *architectural style*. [BCK98] p. 95 recognises two variants of this style – *explicit* and *implicit invocation*. [SG96] p. 23 et seqq. discusses the *implicit invocation* (also known as *reactive integration* or *selective broadcast)* style, which requires a "system component" that invokes the callback functions registered with it by event consumers, whenever an event notification of the appropriate type arrives. Cf. also [Szyp98a] p. 148 et seqq. where the term *connection-oriented programming* is used for the programming style of replacing "statically chained call dependencies by indirections that can be configured at run-time".

[1135] [OMG97r] p. 4-1 et seqq. and [Sieg96] p. 196 et seqq. As pointed out by [OHE96b] p. 121, an event channel may be regarded as a lightweight variant of *Message-Oriented Middleware (MOM),* lacking "MOM-like message priorities, filters, transaction protection, reception confirmation, time-to-live stamps, or sophisticated queue management".

An event channel comes very close to a *software bus,* where producers *publish* named data and consumers *subscribe* for these. *Software buses* were initially intended for the interconnection of different applications that were part of a software development environment (see [Reis90] and cf. also [Beac92] and [PA91]). Recently, there has been a renewed interest in software buses as an interconnection mechanism for software components. *Lotus' InfoBus* (see [Cola99]) is intended for easy interconnection of *Java Beans* and *Java* applets, and also *COM+* supports a publish/subscribe mechanism (see [Chap98b-c], [Plat99] p. 149 et seqq., and below p. 612).

1.2 ENCAPSULATED PROGRAMMING

If we are soundly to put business objects on the footing of a component infrastructure as suggested in the previous section, we must first consider and most likely somehow address the fact that two fundamentally different attitudes to software development underpin *object-orientation* and *software components*. These two attitudes, which may be labelled *animism* and *mechanism,* blatantly clash in the concept of *implementation inheritance,* which, although widely held to be a quintessential element of object-orientation, has for some time been under vigorous attack from some advocates of component-oriented programming due to a skein of problems, conventionally referred to as *the fragile base class problem.* Notwithstanding recent research has enhanced the understanding of this problem-complex considerably, no practicable, complete, and trouble-free recipe for how to "discipline" implementation inheritance so as to avoid the fragility problems has appeared. Below, I will survey and analyse the problem and its suggested cures afresh, thereby also suggesting a taxonomy and reformed nomenclature. Two main variants of the problem, commonly referred to as *syntactic* and *semantic* fragility, have long since been discerned. As a remedy for the former, I propose *dynamic linking and compiling with caching,* which refines a scheme adopted in *Sun's Java Virtual Machine (JVM)* and *Microsoft's Common Language Runtime (CLR).* As an antidote against semantic fragility, I suggest *encapsulated inheritance,* which modifies implementation inheritance by abandoning *polymorphic self-recursive down-calls* and *direct access to superclass data.* These measures, all derivable from well-known principles of *software engineering,* will, I believe, dispel a large range of fragility issues as well as some other problems of implementation inheritance, while still preserving the benefits of easy incremental extensibility and modifiability typical of the object-oriented approach. So by the superimposition of the mechanistic ethos and principles of software componentry on the intrinsically animistic discipline of object-orientation, a somewhat novel programming style, *encapsulated programming,* reconciling and unifying object-orientation and component-orientation, will in effect result, as will a new unit of programming, the *capsule,* which assimilates various features of the hitherto ill-assorted *object* and *component* notions into an integral whole.

1.2.4 ICHABOD TO OBJECTS

Quite a few years ago Grady Booch declared object-orientation the "logical, stable, and final organizing principle for software development".[1136] From the mid-90s, object-oriented programming, however, has been subject to growing criticism and a rather widespread "object scepticism" has made its voice heard in various fora, the popular computer press, and, in particular, amongst practitioners of the programming trade. The stormy petrel of object scepticism will be Jon Udell's eye-catching and much-cited prelude to the *BYTE* May 1994 componentware special:[1137]

> *Object technology failed to deliver on the promise of reuse. Visual Basic's custom controls succeeded. What role will object-oriented programming play in the component-software revolution that's now finally under way?*

A subsequent indication of the declining éclat of object-orientation will be the name changes of the *SIGS* magazines *Object Expert* and *Object Magazine* into *Application Development Advisor* and *Component Strategies*[1138] in 1997 and 1998 respectively and the recent demise of one of the flagships of object-oriented publications, the *Journal of Object-Oriented Programming.* Tellingly, the first issue of *Component Strategies* contained an article entitled *Are Objects Obsolete?* by the well-known author and object strategist David Taylor, where components and agents were identified as "the two prime candidates for the next-generation technology" and object technology was reported to "appear to be on the decline",[1139] whereas in another article also written in 1998[1140] Taylor quipped that object-oriented technology had "gone from cachet to passé". Similar attitudes are ex-

[1136] [Booc91]

[1137] [Udel94a]

[1138] In 1999, *Component Strategies* changed its name once again into *Application Development Trends,* a designation that proved more durable.

[1139] [Tayl98b]. The views expressed in this article entail quite a tergiversation from Taylor's earlier perfervid objections to such views in [Tayl94] and [Tayl95c].

[1140] [Tayl98c]

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pressed also elsewhere,[1141] and warnings against object-oriented hyperbole are often heard from software old-timers, who over the years often grow increasingly sceptical of the seemingly ever-recurrent panacean claims about the latest technological fad, the proverbial "silver bullet".[1142] The phenomenon of object scepticism has been much fomented by the success of component-based *RAD (Rapid Application Development)* environments, such as *Visual Basic* with its *VBX, OCX, ActiveX,* and now *.NET* controls. As per today, object scepticism will be encountered considerably more often in industry than in academe[1143], although since the late 90s there have been sporadic signs that also the academic winds may be on the cusp of veering. The first major attack on object-orientation by an academically well-established researcher was Clemens Szyperski's successful book, suggestively entitled *Component Software. Beyond Object-Oriented Programming,*[1144] presently expected to appear in a second edition very soon.

Admittedly, the misgivings about object-oriented programming have been somewhat curbed by the *Java* furore, astutely characterised as "a fine mix of jihad and tulipomania" by one observer[1145], and by the widespread belief amongst object advocates that the noticed problems of object-orientation stem from deficiencies inherent in widely used object-oriented programming languages – in particular *C++* – rather than in object-orientation *per se.*[1146] The popularity of *Java* will, however, primarily be a consequence of the success of the *Internet* and the aptitude of the byte code execution model for *Internet* programming and has only limited bearing on the question of the virtues and vices of the object-oriented programming paradigm. Additionally, if the advocates of components are right in their critique of object-orientation, the current success of *Java* may be something of a Pyrrhic victory, bound to be ensued by a rude awakening to the period of disillusionment and sobering afterthought, criticism, and analysis that has followed upon most earlier fits of the recurrent disease of language tulipomania, including the *C++* one, which raged not too long ago.[1147] Hopefully, we will below be able to provide some food for thought about the general direction such a future analysis may take.

There is, it transpires, a fundamental, almost philosophical tension in outlook between ***object-orientation*** and ***software componentry***. Whereas ***object-orientation*** is an approach based on hierarchical modelling of real or imagined exemplars, the starting point of ***software components*** is the idea that software should be assembled from prefabricated, reusable parts just as hardware and, indeed, most products of human industry and engineering are. Thus, ***object-orientation*** is grounded in the modelling concept of inheritance and ***software componentry*** in the production-oriented concept of encapsulation of parts, but how to combine these two conceptions is, it appears, a most difficult and delicate matter. Certainly, we must ask ourselves: Can component-orientation and object-orientation be felicitously reconciled at all? Are they perhaps supplementary to each other? Or do they rather preclude each other? And, if so, do the aforementioned omina portend the future surcease of objects? Or perhaps of components?

The principal butt of the component school's attacks is ***implementation inheritance,*** the very lynchpin of object-orientation, which, for instance, is thus strikingly denounced by Cuno Pfister, the chairman of *Oberon microsystems:* "It may well turn out that implementation inheritance is the GOTO statement of the nineties".[1148]

[1141] See, for example, [GL99].

[1142] See e.g. [BE94], [Brya96], or [HKL98].

[1143] The results of the Gallup poll presented in [John00] seems to contradict this observation, but may not be very representative of the real state of affairs, as the criteria for the selection of the respondents (subscribers for the *Communications of the ACM* or *OOPS messenger* or registrants at the *OOPSLA* conferences) certainly favour developers with strong technical and object-oriented interests and commitments. Arguably, it would have been more interesting to make a poll amongst programmers with extensive experience in ***both*** object-oriented and *RAD* programming.

[1144] [Szyp98a]

[1145] [Kell98b]

[1146] Cf. [Webs95a] p. 138 et seqq. and the perplexing lampoon [Joyn96], recently followed by a book [Joyn99] in the same spirit.

[1147] [Lewi97] p. 136 calls this phenomenon the *UNCOL (Universal Common Language) Problem* and cites a number of previous *UNCOL* candidates, such as *Algol, Pascal, PL/I, Ada,* and *C++*. More commonly, *UNCOL* is spelled out as *Universal Computer-Oriented Language* and is used to signify a universal intermediate language, to which code in any *Problem-Oriented Language (POL)* can be translated and from which code for any *Machine Language (ML)* can be generated. See [SWTO+58a-b], [Conw58], and [PW69]. Cf. also [Fran94]. Numerous critiques of *Java* have been put together by various malcontents – see, for example, [Fran98b] or [Thim99].

[1148] [Pfis97b]. Already [PB92] criticised ***polymorphism*** as a disguised ***goto***. In contrast, [Webs95a] is not couched as a critique of object-orientation, but as a survey of potential "pitfalls" – managerial as well as technical – when using object-oriented techniques, although

Additionally, many of the serious troubles of *object-oriented frameworks* identified by a group of researchers at the University of Karlskrona/Ronneby – and experienced by innumerable practitioners of the object-oriented paradigm – seem to derive from the problems of implementation inheritance.[1149] The encountered or envisioned fragility problems of implementation inheritance caused the designers of *Microsoft's Component Object Model (COM),* the as yet most successful component infrastructure, to boldly abandon it altogether.[1150] In contrast, competing component technologies, such as *OpenDoc, JavaBeans,* and most recently also *Microsoft's* own *.NET,* have preserved the support for implementation inheritance, thereby, however, also retaining the liability to its darker sides.

Naturally, the question whether implementation inheritance can be somehow modified or disciplined so as to avoid the fragility problems has lately begun to attract increasing attention, and this question also provides the theme and motivation of the present study, prompting us to frame the concepts of *dynamic linking and compiling with caching* and *encapsulated inheritance* and to suggest them as antidotes against the fragility malaise. Before delving into the intricacies of inheritance we will, however, attempt some reflections on the nature of the two concepts at stake, *components* and *objects*.

1.2.5 ANIMISM AND MECHANISM IN COMPUTING

In a shady past, computing was an exclusively human activity and "computer" was the title of an officer doing computations for a living.[1151] When von Neumann designed his famous architecture for an electronic, automatic analogue of such "computers" of flesh and blood, he loosely modelled it on the human mind – the memory, control, arithmetic, input, and output "organs" all have their counterparts in the mind and senses of man.[1152] Indigenous to such an anthropomorphic architecture will be a certain dualism, an antinomy between a *mechanistic* and an *animistic* conception: Viewed from the outside, the computer appears as a *machine,* but viewed from the inside it seems to possess a distinctly mental flavour and is more like a *mind,* where programme execution corresponds to the discursive flow of human thought.[1153] This latter view is reflected in the notion of the computer as an *electronic brain* so popular in the 50s.

In order to control or "programme" such an electronic brain, it seems – if nothing else, by sheer anthropomorphic analogy – reasonable to take advantage of a synthetic language. The first programming languages rather straightforwardly mirrored the calculation- and business-oriented interests and biases of the early computer owners and users. As a consequence of the invention of the *integrated circuit,* a capability and miniaturisation revolution of the computer took place during the 60s, facilitating the construction of much larger and more complex computer software than was possible before. This revolution became the ferment and backdrop of the "software crisis", the rise of software engineering, and a hectic development of programming language technology. Notably, in the late 60s the dualism between the mechanistic and the animistic view-

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some of these "pitfalls" indeed pinpoint weak spots of the object-oriented approach. On such pitfalls, see also [Grah94] p. 46 et seqq., [Copl94] p. 249 et seqq., and [McCo96] p. 367.

1149 [BMMB99] and [MB97a]. See also [Matt00].

1150 Interestingly, [Box98b] interpreted component-orientation as a "refinement" of object-orientation. He discerned three "waves" of object-oriented programming models, to wit the well-known *class-based* model, which bundles *state* and *behaviour* together as well as *interface* (type) and *implementation* and uses *implementation inheritance* as a vehicle of polymorphism and (white-box) reuse (e.g. *C++, Smalltalk),* the *interface-based* model, which unbundles *interface* and *implementation* and uses *interface inheritance* as a vehicle of polymorphism and (black-box) reuse (e.g. *COM,* the *Orbix CORBA ORB, Java),* and the *state-conscious* model, which additionally separates *state* and *behaviour* in order to support distributed application development (e.g. *Microsoft Transaction Server).* Whereas this evolutionary scheme probably reflected the semi-official *Microsoft* view of these things at the time Box wrote his article, *.NET* changed it all by introducing full support for the traditional object-oriented model.

1151 Cf. [CA96] p. 9 et seqq.

1152 See [Neum45], [BGN47], and [Neum58]. Cf. also [Wien48] p. 7 et seqq., [Berk49], [Turi50], [Bair81], and [Rhei00]. The binary operation of relays or vacuum tubes was understood as modelling a "simplified neuron" of the kind suggested in [MP43]. The long and fascinating history of the human obsession with the creation of artificial life and automata is traced in [Cohe66] and [Bedi64]. Cf. also [Kurz90].

1153 This dualism is the starting point also of the epiphenomenalist theory of "functionalism" suggested by Hilary Putnam and others, according to whom mental states are to be understood as "functions" of the neural system, related to this in a way similar to the way a programme is related to a computer. Cf. also [Soll64], [Soll67], [HKS93], and [Davi98] p. 129 et seqq.

points reappeared in the guise of two major new strategies of battling the increasing problems of software complexity, viz. *components* and *objects.*

The notion that software could – and should – be built from prefabricated *components* in a manner similar to hardware and indeed most industrially produced artefacts goes back at least to McIlroy's famous invited address *Mass Produced Software Components,* delivered at the *NATO* conference on software engineering in Garmisch in 1968.[1154] This idea is based on a mechanistic conception of software, a *machine metaphor* that makes *encapsulation* the keystone of programming. In contrast, object-orientation, which surfaced slightly earlier through the *SIMULA 67* language[1155], is based on a *world metaphor,* which arises naturally in the domain of software simulations, the cradle of the object-oriented approach.[1156] For that reason, the allure of object-oriented software largely consists in its embodiment of a *mental* or *conceptual model*[1157] of a set of real-world or imaginative entities, which, in effect, renders an object-oriented programme akin to an animistic microcosm of message-exchanging objects.[1158]

Both *software components* and *object-orientation* led rather shadowy lives during the 70s. The *component* idea might have been vaguely operative in the background, when concepts such as data abstraction, information hiding, and modularity were developed[1159], but in the main seems to have been ignored or forgotten.[1160] In contrast, object-orientation went through an intense period of development at the laboratories of *Xerox PARC,* but this largely happened in a kind of semi-isolation from the rest of the computing world and from the mainstream developments and currents of the time.[1161]

During the 80s, the interest in both object-orientation and software componentry/reuse suddenly exploded. At this time, Brad Cox laid the foundation of the modern notion of a component by making the ingenious and intriguing identification of the *component* and *object* concepts.[1162] Cox' *Software-ICs* were binary packaged *objects,* possessing many of the dynamic properties now widely believed to be necessary for components. Blithely unaware of the future mêlées over this matter, Cox also included implementation inheritance into the armoury of his *Software-ICs,* although the design of these in fact deftly avoided some – but not all – of the fragility problems later to become so heatedly debated. We will now attempt to enucleate the consequences of Cox' design, which, in effect, appears as a brave endeavour at the unification of the two attitudes to software development we have called *animism* and *mechanism.* In order to be able to do so, we will first take a look at the nature and properties of the *inheritance* mechanism at large.

[1154] [McIl68]. See also above p. 28 et seqq.

[1155] See [DN66], [ND78], and footnote 552 on p. 125 above.

[1156] In an *ICSE* keynote talk [Jack95] some years ago, Michael Jackson also dwelt on the concepts of *the world* and *the machine* and their rôles in the context of software development and engineering. Cf. also [Jack94] and [EFM97].

[1157] [Inga81] takes the position that objects should be compatible not with reality *per se,* but with the models of it in the minds of human observers. See also [Aran89], [HKL95] p. 57 et seqq., and [John83]. [Lyyt83] provides a critique of reality modelling and instead advocates "language modelling".

[1158] The objects of object-oriented programming differ from those of the real world, insofar as they possess a universal capability to send and receive messages and thus appear more like animate beings than thing-like objects. Since the world metaphor of the objected-oriented programming paradigm is somewhat maladroitly bodied out in a programming *language,* where all activity is brought about through programme instructions and, hence, the direct manipulability of physical objects typical of the real world necessarily will be absent, this hylozoic impression naturally arises.

[1159] So [Wegn84] p. 12.

[1160] See above p. 31.

[1161] See [Kay77], [KG77], and [Kay93].

[1162] See [LC85] and [Cox86]. In an *IFIP* keynote speech [Ichb83], Jean Ichbiah likewise associated the *package* and *generics* facilities of *Ada* with the software component vision of McIlroy. In a similar vein, Grady Booch later (in [Booc87] p. 7 et passim) formulated and forcefully promulgated an *Ada* component programme. In popular lore, a Scandinavian modelling-oriented branch of object-orientation is often opposed to an American reuse-oriented one; cf. e.g. [Kerr93].

1.2.6 INHERITANCE – THE TILT-YARD OF OBJECTS AND COMPONENTS

Inheritance has become the tilt-yard where object-orientation's knightly aspiration to model the world in reusable white-box hierarchies has come to joust with the no less chivalrous principle of black-box encapsulation, upon which software components – as well as componentry in general – firmly rest.[1163] Inheritance is widely held to be the *differentia specifica* of object-orientation[1164], endowing it with a flexible and useful extension mechanism, but has become increasingly controversial, as it has become clear that it is also the source of miscellaneous inexpediencies and vexations. In particular, the question, whether *components* intended for distribution on an open market should support inheritance or not, has been heatedly debated during the last decade, and as the crux of the matter has crystallised the much harped-on *fragile base class* problem, which we will soon come back to. This is hardly the place to arrange a regular quodlibet on the vices and virtues of object-orientation in general and inheritance in particular, but a quick glance will be cast at some of the points at issue.

According to Wegner and others, inheritance is essentially a mechanism for the "incremental modification" of a superclass by a subclass[1165] making possible a programming style aptly called *programming-by-difference.*[1166] Such modifications can be brought about by adding new methods and new data members to the subclass or by changing the implementation of superclass methods in the subclass through method *overriding.*[1167] Besides inheritance, *polymorphism* is generally considered essential to object-oriented programming.[1168] When *polymorphism* is supported, variables and parameters may hold or refer to data of more than one type, whereas the antonym *monomorphism* implies that any specific variable in a programme must be of one and only one type. In object-oriented programming, *polymorphism* is yoked closely together with inheritance, insofar as object references usually are *polymorphic* and refer to objects that may be either of the type of the object reference or of any *subtype* thereof. In some programming languages that support dynamic typing, such as *Smalltalk* or *Objective-C,* object references may hold references to any type of object. When polymorphism is taken advantage of, method resolution will happen at run-time by means of *dynamic* or *late binding.*

There are two distinct variants of inheritance, *interface inheritance* (also known as *subtyping)* and *implementation inheritance* (also known as *subclassing).*[1169] The former denotes the inheritance of the *type* (i.e. interface or protocol), the latter the inheritance of *behaviour* and *state* (i.e. implementation or "code"). Thus, *interface inheritance,* providing a *classification mechanism,* will naturally tune in with *conceptual, hierarchical modelling,* while *implementation inheritance* plays the rôle of a mechanism for *code reuse* and *code sharing* useful in programming.[1170] Thus, these two kinds of inheritance will be primarily concerned with *substitutability* and *extensibility,* respectively.

[1163] Thorough and up-to-date treatments of inheritance and its problems are found in [Szyp98a] p. 72 et seqq. and [Meye97] p. 459 et seqq. et passim. Id. op. p. 809 et seqq. (see also [Meye96]) proposes an interesting taxonomy of inheritance and also includes a survey of biological taxonomy. See also [EKSM97], where no less than 16 different concepts that can be realised via inheritance are identified. [Taiv93] is a dissertation, [Taiv96] a comprehensive survey article devoted solely to inheritance.

[1164] So [Wegn87] p. 169, where the classical definition "object-oriented = objects + classes + inheritance" was set down. Of course, not all will agree with this definition. For example, [Sakk89] and [Fröh02] argue that inheritance is not central to object-orientation at all.

[1165] [Wegn88]. Cf. also [Taiv96] p. 474. This interpretation holds quite well for single inheritance. When multiple inheritance is considered, inheritance may additionally become a mechanism for the combination or *mix-in* of useful behaviour.

[1166] [JF88]

[1167] *Overriding,* which pertains to methods with identical signatures, is distinct from *overloading,* which pertains to methods with different argument types, but the same name; cf. [ADZ01]. Some languages, such as *Eiffel,* also support the cancellation and/or renaming of superclass methods – and, possibly, data – in the subclass, although such flexibility is often considered undesirable or harmful.

[1168] [CW85] discerns and discusses various forms of polymorphism.

[1169] See [Lisk87], [Amer87], [Amer90], and [BarD92]. Neither subclassing, nor subtyping is identical to the *is-a generalisation/specialisation relationship* used in modelling, as pointed out in [LP91], although some authors, such as [BB95b], equate is-a relationships and subtyping. See also [Kuo95], [AM94], and [AS01]. There are also other terms in use for these notions. For instance, some authors use *extension inheritance* or *behavioural inheritance* as synonyms for subtyping and *specialisation inheritance, module inheritance,* or *class inheritance* for subclassing, but these terms will be avoided here, as they are used quite differently by different authors.

[1170] According to the taxonomy suggested in [Meye96] and [Meye97] p. 824 et seqq., there are three main types of inheritance: *model inheritance,* "which reflects "is-a" relations between abstractions in the model", *software inheritance,* "which expresses relations within the software itself rather than in the model", and *variation inheritance,* "which describes a class by how it differs from another class (a special case that may pertain either to the software or to the model)".

Whereas *interface inheritance* is generally considered beneficial and uncontroversial[1171], *implementation inheritance* has ever and anon been decried as uninteresting[1172] or potentially maleficent[1173]. Technologies such as *COM* and *CORBA* directly support only interface inheritance, but most object-oriented programming languages merge interface and implementation inheritance into one concept. An important exception is *Java,* which offers a clear-cut separation of the two inheritance types. In *C++,* pure interface inheritance may be simulated through public inheritance of an abstract class, which has only pure virtual function members, whilst pure implementation inheritance may be simulated with private inheritance.[1174]

2.1.1.1 Inheritance – A Miscellany of Difficulties

Amongst the problems of inheritance, one much debated category is related to *multiple inheritance,* i.e. the possibility to inherit from more than one base class.[1175] This category will include rather trivial difficulties, such as name clashes that, once detected, generally are easily resolved, as well as various more virulent difficulties, which haunt diamond-shaped inheritance graphs. Such diamond graphs will show up frequently when superclasses are parts of a framework shaped as a tree with a common "cosmic object" in the root position. Hence, when multiple inheritance is supported, frameworks should adhere to the "forest model" of many disjunct, shallow inheritance graphs rather than to the vicious "tree model" – this obvious and clearly problem-dispelling rule has been strangely little honoured by framework constructors.

Inheritance is sometimes said to "break encapsulation", because it makes superclasses expose implementation details to their subclasses.[1176] In this context, it is important to note that, in general, a class exposes two interfaces that usually intersect: the *client interface* intended for "ordinary" run-time method calling and access of data and the *specialisation interface* intended for subclassing.[1177] In many object-oriented languages, such as *C++* and *Java*, it is possible to restrict access to methods and instance data by the use of access modifiers. In *C++* and *Java,* the methods and data belonging to the client interface are declared *public,* those of the specialisation interface *protected,* and implementation details, which should be accessible through neither interface, *private.* In both these languages, the members of the client interface will always be part of the specialisation interface as well.

Whereas strict observance of the principles of *information hiding* and *data abstraction* will mitigate the problem of encapsulation break[1178], it will still at times be necessary to have access to the source code of the implementation of a superclass in order to be able to correctly implement a subclass. In particular, this will often be the case when a superclass method is overridden by a method in the subclass or when the subclass defines a method that will be recursively called from the superclass – although the need for source code access is by no means restricted to these cases.[1179] The reason why this is so is that a subclass – in contrast to an ordinary

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[1171] However, [Berr95] questions the aptitude of inheritance for the *modelling* of an inherently fuzzy real world. See also [Meye96] p. 106 and [Meye97] p. 825 et seqq. for a discussion of some well-known problems of "model inheritance", such as the relation of circles and ellipses and rectangles and squares.

[1172] So, for example, [Lisk87] p. 33 and p. 24.

[1173] See [Magn91] and [Rumb93]. Cf. also [AM94], who castigate "haphazard inheritance", i.e. "the undisciplined use of inheritance to maximise code reuse", or [Torg02], who praises "specialisationism" and denounces "modificationism". In [Meye96] p. 105 and [Meye97] p. 824, such inheritance is called "convenience inheritance". Some other authors use the term "implementation inheritance" more or less as a synonym for such "bad" inheritance – no such connotations are intended by the use of this term in the present study. Various attempts to study the effects of object-orientation and inheritance empirically have been made – two examples are [LHKS92], in which programmer productivity is reported to increase as a result of object-oriented code reuse, and [PD01], in which are described some experiments indicating that the use of inheritance diminishes the modifiability of business domain models.

[1174] [GHJV94] p. 17.

[1175] [Meye97] p. 519 et seqq., [Szyp98a] p. 98 et seqq., and [Sing95] survey the issues involved.

[1176] [Snyd86]

[1177] [Lamp93]

[1178] Cf. [Lisk87].

[1179] Just to get some idea of the severity of the problems, consider what happens, if a superclass method *A* calls a virtual method *B* that is overridden in a subclass and the subclass implementation of *B* then calls *A* – note that the calls may be indirect. Clearly, in order to be

client – will share the very important variable *self* (also known as *this)* with its superclass. Inheritance-based reuse is often referred to as *white-box* reuse, because source code access is required for the specialisation of the reused code. Indeed, this need for source code is a very serious drawback, and for the purposes of a component market, extensibility mechanisms supporting *black-box* reuse, such as aggregation, are frequently claimed to be preferable to white-box mechanisms.[1180]

Another category of criticisms against inheritance concerns the complexities of understanding the control flow in object-oriented systems as epitomised by the *yoyo problem,* i.e. the tendency of control to "yoyo" up and down inheritance hierarchies.[1181] A somewhat related lack of cognitive limpidity shows in the difficulties of upholding the invariants of an object when object re-entrance may occur, typically as a consequence of direct or indirect self-recursion and often leading to puzzling self-interference phenomena.[1182] There are many additional subtle aspects of inheritance, but we will have to refer to the literature for a discussion of these and will now return to *the fragile base class problem* mentioned at the outset of the current section.

2.1.1.2 "The Fragile Base Class Problem"

The locution "the fragile base class problem" seems to have emerged within *Microsoft* during the design and development of its component infrastructure *COM.*[1183] Strictly speaking, this term seems somewhat inappropriate, since, what is "broken" and thus "fragile", in most cases will be a subclass rather than a base class, whereas the underlying *causes* of the fragility often lie with a base class.[1184] Confusingly, some authors use the term also for scenarios, where neither a base class, nor a subclass, but a *client* of a class is what "breaks". In our contention, the term "the fragile base class problem" is misleading and should be abandoned. As a general term for fragility problems that pertain to the use of classes, we instead suggest the term *the fragile class problem,* or *class fragility* for short. As for subclass fragility, *the fragile subclass problem* seems to be the proper term, whereas *the fragile client problem* will be a reasonably telltale designation for the client variant.[1185]

Moreover, the term "the fragile base class problem" is made to refer to different phenomena by different authors. Mostly, the concept is understood as referring to problems that occur when base class implementations evolve independently of their subclasses.[1186] Some authors, however, also use the term to indicate the already touched upon type of fragility that may result from attempts to derive and implement subclasses without access to the source code of the superclass.[1187] These two problems are actually deeply entangled and may well be viewed as different sides of the same coin. Hereinafter, I will refer to the source code problem as *the static fragile class problem* and use the term *the evolutionary fragile class problem* for the evolutionary scenario. Whereas the latter problem haunts both clients and subclasses, the former primarily pertains to subclasses, although

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able to avoid non-terminating loops of recursive invocations or at least to comprehend why the code locks up, a subclass implementer needs access to the source code of the superclasses.

1180 [BW97] argues that a *grey-box* approach, involving the disclosure of only the implementation details a user will need to know in order to use the component correctly, is preferable and that some kind of specification language or notation will be needed for this "partial disclosure of implementation". [GR95] p. 208 et seq. makes a distinction between *glass box* and *white box* reuse. Whereas the latter lets you see as well as alter the implementation, the former will prevent you from making modifications. According to [Soll67], the "black box" was originally the designation of a kind of pedagogical tool introduced at the *Cavendish Laboratories* in Cambridge in the 1880s to teach students how to analyse electrical circuitry.

1181 [TGP89a-b]. [PB92] even goes as far as to compare polymorphism to the ill-famed *goto* statement.

1182 See [Szyp98a] p. 57 et seqq. and [MSL99].

1183 The description, albeit not the designation, of the problem can be found already in [Will90a] p. 10, a draft paper on inheritance by the chief architect of *COM,* Anthony Williams.

1184 [GM96] instead uses the term "the fragile superclass problem", which, however, seems equally unfortunate.

1185 Similarly, [Lewi97] p. 135 differentiates *the fragile base class problem,* "whereby interface changes to abstract classes destroy entire class hierarchies" from *the fragile interface problem,* "whereby one change in an interface specification can propagate to all points in a large program that use the interface".

1186 So, for example, [Betz94], [MS97a-b], [MS98], and [Szyp98a] p. 102 et seqq. [MS97a], [MS98], and [Szyp98a] provide detailed accounts of this problem.

1187 [Broc95] p. 96 et seqq. [WK94] appendix 1 discusses both problems, but does not use the term "fragile base class". On this problem, see also [RL00], who call it "semantic fragile subclassing problem".

there may indeed be some cases, when a programmer needs to consult the source code in order to grasp how to interact with a class correctly as a client. We will here be primarily concerned with *the evolutionary fragile class problem* and when we use the term *the fragile class problem* without further qualification, it can be assumed that it is the evolutionary variant that is being referred to.

Also *the evolutionary fragile class problem* falls into two distinct varieties, often referred to as the *syntactic* and the *semantic fragile base class* problem.[1188] In keeping with the terminological principles just outlined, these terms, which will be explained at some length below, should in our view rather be named the *syntactic fragile class problem* and *the semantic fragile class problem,* respectively.

2.1.1.3 The Syntactic Fragile Class Problem

Source code references to *external* functions and data (i.e. functions and data defined outside the current source code file) are traditionally resolved at "link time" through *static linking* by a linker. More recently, run-time or *dynamic linking* to *Dynamic Link Libraries (DLLs)* has caught the wind in *GUI* environments, such as *Windows* and *OS/2* – the *UNIX* counterpart is known as "shared libraries".[1189] In *Windows,* or to be more precise *Win32,* to which our account of this mechanism will primarily appertain[1190], all functions and data exported by a *DLL* should be prefixed by a special keyword in the source code.[1191] When the *DLL* is linked, an *import library* (i.e. a .LIB file) holding a list of the exported symbols of the *DLL* is automatically created and an *export table* with these symbols is inserted into the *DLL.* Each entry of the export table holds the name of the exported symbol as well as its address inside the *DLL* and some other pieces of information. During the linking of an *EXE* or *DLL,* the linker resolves any external source code references[1192] by searching the *LIB* files included in the link process and step by step builds an *import table,* which is inserted into the executable file. This table holds the names of the external functions and variables together with the names of the *DLLs,* where each symbol is located.

When an executable programme is about to be loaded into memory, the loader examines the import table and loads all *DLLs* needed that are not already in memory and maps them into the virtual address space of the application. Additionally, another table is built by the loader, holding the symbols of the import table, their actual addresses in memory, and some other pieces of data. Whenever an external reference is encountered during execution, this table will be used to find the address of the symbol in question.[1193] Consequently, there is a run-time performance penalty of an extra memory indirection for each external reference.[1194] Although many applications may share a *DLL,* each application will have a separate set-up of the global and static variables of the *DLL,* and the *DLL* will use the heap and stack of the calling application for dynamically allocated memory, local variables, etc.

Dynamic linking makes it possible to upgrade a *DLL* without having to re-compile and re-link all applications that use it, provided that the functions and the data referenced by these are not removed, renamed, or their types/signatures changed in the new *DLL.* This is a major benefit, making it easy to distribute fixes and upgrades of libraries shared by a large number of programmes without breaking these. For one thing, the

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[1188] [PS94], [PS96], [MS97a], [Pfis97b] chapter 3.4., and [Szyp98a] p. 102 et seqq.

[1189] [Fran97] presents an interesting bird's eye-view of the different varieties of *dynamic linking* and tracks the concept back to the *Multics* operating system of the 60s (see [CV65] p. 191).

[1190] Our account is based on [Rich97] p. 529 et seqq. and [Petz99] p. 1243 et seqq. On the new *.NET DLL* model, which is an entirely different kettle of fish and will not concern us further here, see [Chap02] p. 86 et seqq.

[1191] *__declspec(dllexport)*

[1192] In *C/C++,* these symbols are singled out by prefixing them with the *__declspec(dllimport)* keyword or by simply declaring them *extern.*

[1193] In addition to such *load-time* or *implicit dynamic linking,* it is possible to use *run-time* or *explicit dynamic linking* by loading a *DLL* at run-time through the *LoadLibrary API* call and retrieve a pointer to any function inside the loaded *DLL* through a call of *GetProcAddress* together with a string argument that identifies the function to be retrieved. The function may then be invoked through the returned pointer.

[1194] As pointed out in [Fran97], this *run-time lookup* may be eschewed through *load-time code modification.* If a list of the addresses of all references to an external symbol is saved in the *import table,* a *linking loader* may insert the machine code for the calls at the correct locations in the binaries, thereby eliminating the table-lookup. The cost for this will be an increase in table space consumption and in load time. Linking may even be deferred until run-time *(demand linking* or *lazy linking),* although this may render programme execution a little jerky.

Windows API is distributed as a set of *DLLs*. Unfortunately, this "upgradability" is only possible when procedure-oriented languages, such as *C,* are used; when object-oriented languages are relied upon, *the syntactic fragile class problem* will wreak havoc upon it.

There are two variants of *the syntactic fragile class problem*. The *syntactic fragile subclass problem* refers to the need to recompile *unmodified* subclasses, when changes in the interface of a base class have been made, lest the subclasses should "break" during execution. Recompilation will frequently be necessary even upon apparently very harmless changes to the interface of the base class, such as a simple reordering of its members. Closely related to this problem is *the syntactic fragile client problem,* which haunts clients in a similar way, necessitating the recompilation of the unmodified clients of a class upon changes in the class interface. Both problems result from the tabular organisation of virtual methods and instance data in the compiled and linked binaries of object-oriented programmes. Unfortunately, the layout and size of these tables, which need to be known at compile-time, will tend to be affected by any modification to the class interface, however slight.[1195]

To understand the nature of these problems accurately, one will need to be somewhat *au fait* with how the run-time system of an object-oriented language is typically implemented, which I therefore will now attempt to explain. Most objects in an objected-oriented programme will end up on the *heap,* a chunk of memory from which smaller chunks of memory can be allocated dynamically.[1196] When an object is created, an *activation record* will be allocated, holding various pieces of information, including a block of instance data and a pointer to a *class template* or *prototype,* which is shared by all instances of the class.[1197] The *class template* will, in turn, contain another table (or a pointer to it), variously referred to as a *method dispatch table, virtual table, vtable,* or *vtbl,* which contains pointers to all the virtual methods of the class and very often of its superclasses as well. In typical *C++* implementations, such as the one depicted in *Figure 19,* the *class template* is replaced by a bare *vtbl,* which contains the methods of the current class and all its superclasses.[1198]

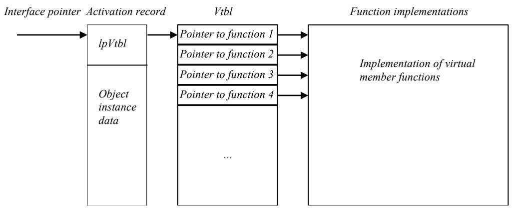

Figure 19. Typical C++ object layout

There are two obnoxious consequences of the above approach. Firstly, since the size and layout of the *activation record* and the *vtable* of a class are dependent on the set of instance variables and methods of all its superclasses, this set must be known at compile time in order for the compiler to generate correct code for the *vtable* and for object creation and instantiation. Consequently, most changes to the interface of a superclass will cause compiled subclasses to break, unless they are recompiled. This is the primary cause of the *syntactic fragile subclass problem.*

Secondly, when the compiler generates code that references an object, it cannot determine the *absolute addresses* of the instance data of the object, which in most cases will be allocated dynamically only at run-time, nor those of virtual methods, since the class of a dynamically allocated object is not generally known at compile-time because of polymorphism and late binding.[1199] However, the compiler can – and generally will – de-

[1195] As shown by [ESJ02], there are also other similar problems, which may supervene upon class library evolution when subclassing and dynamic linking are combined. These include *blind clients,* i.e. the phenomenon of client code being unaffected by modifications made to the class library, and *fragile clients,* i.e. clients, which continue to run correctly despite apparently fatal alterations made to the class library and do not break until they are re-compiled. None of these problems will be dealt with here.

[1196] Some object-oriented languages, such as *C++,* also support globally and statically allocated objects and objects allocated on the stack.

[1197] Cf. [Erik84] p. 89 et seqq. and [Magn93], which describe a *SIMULA* variant of these mechanisms.

[1198] So, for example, in the *C++* implementation suggested in [ES90] p. 227 et seqq. Furthermore, if a *C++* class lacks virtual member functions, the *vtbl* may not be allocated at all. In *C++,* the matter is further complicated by the support for *multiple inheritance,* which may be implemented through concatenated activation records, each equipped with its own separate vtable.

[1199] Technically speaking, the *dynamic qualification* of an object reference may differ from its *static qualification.* For instance, given a class hierarchy consisting of a *Vehicle* base class and two subclasses, *Car* and *Aeroplane,* a reference having the *static qualification Vehicle* may well

termine the *offset* or *relative address* of a variable inside the data area of its activation record as well as of a virtual method inside its *vtable.* These offsets may be used during code generation:

```
Vehicle *vehicle=new Car;
vehicle->drive(10);
```

will possibly result in the generation of code like this:

```
(*(vehicle->vptr[7]))(vehicle,10);
```

Such code, which is said to rely on *offset resolution,* is extremely fragile, since it is dependent on a fix ordering of data and virtual function members, and its use both gives rise to the *syntactic fragile client problem* and aggravates the *subclass problem*: A large range of modifications of the interface of a class may now make clients and subclasses "break", including seemingly innocent measures, such as adding a method or a data item to a class, reordering its members, making a method virtual, or deleting a private member. This is in stark contrast to the resilience typical of procedural *DLLs,* where these kinds of changes (if meaningful) will be wholly unproblematic.[1200] It is also glaringly at odds with the important software engineering principle of *encapsulation,* frequently also claimed to be a hallmark of object-orientation.

Syntactic fragility causes two problems, *recompilation avalanches* and lack of *release-to-release binary compatibility*. The former snag affects productivity adversely, as applications grow large and developers spend increasingly more time waiting for compilation and linking to complete. *Recompilation avalanches* constitute a major nuisance in compiled object-oriented languages, exacerbated by the across-the-board use of file inclusion directives and file time stamps to determine which code needs recompilation.[1201] In *C++* and some other languages, the problem is primarily restricted to class interface changes by the clear-cut separation of the class interface from its implementation through *header files,* although some implementation details exposed by the interface of a class, such as in-line function members, may occasionally add to this kind of fragility.[1202] Languages that do not keep interface and implementation apart in different files will be more vulnerable to this variety of syntactic fragility, as not only interface changes, but any changes to the implementation part of a class will necessitate the recompilation of subclasses and clients.

In contrast, the lack of *release-to-release binary compatibility* affects system reliability adversely, inasmuch as the introduction of a new version of an object-oriented *DLL* will possibly invalidate all applications that rely on this *DLL,* as the offsets used to address data and virtual function members as well as the table sizes and layouts presumed by subclasses may no longer be correct.

2.1.1.4 The Semantic Fragile Class Problem

The *semantic fragile class problem* is much more elusive in nature than its *syntactic* sibling, as it arises from evolutionary changes not to the *interface* of a class, but to its *implementation.* It may show up, whenever a new version of a base class, from which subclasses have been derived through *implementation inheritance,* is introduced, if the base class makes a – direct or indirect – *polymorphic self-recursive down-call.* Since every *polymorphic self-call* may potentially be resolved into a down-call, we can just as well say that the problem is latently overhanging in any class that makes at least one *polymorphic self-call.* In addition, it may show up upon revision

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have a *dynamic qualification* of *Car* or *Aeroplane,* i.e. point to a *Car* or an *Aeroplane* object. It should be noted that non-virtual methods can be resolved at compile-time.

[1200] In order to make objects reusable across different compilers and programming languages, a binary standard for the layout of objects is also needed. *Microsoft's COM (Component Object Model)* offers such a standard that rests on the *vtable* layout of *Figure 19*.

[1201] *Fingerprints,* which are hash values of interfaces or the individual members of an interface, may be used to make recompilation decisions more fine-granular. See [Fran97] p. 75 et seq.

[1202] Private member declarations are indeed implementation details and should consequently not be exposed in the interface of an object. In *C++,* modification of private members will, however, change the table layout and offsets and, thus, must be part of the class interface. Additionally, the existence of *friend* declarations or *inline* functions may bring to naught the encapsulation of private members. In the *BeOS* system *APIs,* which are exposed as *C++* classes, various – mostly very awkward – workarounds to the *C++* fragility problems are resorted to, as documented by [Potr97].

of a base class, the instance data of which are directly accessed from a subclass. Mikhajlov and Sekerinski, who have investigated this problem at length, discern five distinct cases of it, some of which are rather involved.[1203]

A source code example will convey the flavour of the problems:[1204]

```
class IntArray {
public:
  IntArray(int sz):len(sz) { data=new int[sz]; }
  virtual void insert(int i) {
    if (n<len)
      data[n++]=i;
  }
  virtual void append(IntArray &a) {
    for (int i=0; i<a.len; i++)
      insert(a.data[i]); // Polymorphic self-call!
  }
private:
  int *data; int len; int n=0;
};

class SumArray: IntArray {
public:
  SumArray(int sz): IntArray(sz) {}
  virtual void insert(int i) {
    sum+=i; IntArray::insert(i);
  }
  virtual int GetSum(void) { return sum; }
private:
  int sum=0;
};
```

The *IntArray* base class implements a very simple integer array, to which the *SumArray* subclass adds functionality for retrieving the sum of the integers of the array. Please note the *polymorphic self-call* in the method *append* of *IntArray*. Now, consider what happens, if we change the base class method *append* slightly:

```
class IntArray {
public:
  IntArray(int sz):len(sz) { data=new int[sz]; }
  virtual void insert(int i) {
    if (n<len)
      data[n++]=i;
  }
  virtual void append(IntArray &a) {
    for (int i=0; n<len && i<a.len; i++)
      data[n++]=a.data[i]; // Self-call removed!
  }
private:
  int *data; int len; int n=0;
};
```

Because of a slight, entirely behaviour-preserving change inside the *append* operation, the *GetSum* method of the subclass will no longer return the correct sum of the integer array!

Apparently, semantic fragility problems may be very insidious and hard to cope with. For one thing, it will of course always be possible to make subclasses break or malfunction during base class evolution by introducing errors that incorrectly alter the semantics of superclass methods called from a subclass. If, for example, an "add" method starts to do subtraction instead of addition, all operations that rely on it are most likely to start to malfunction, be they client methods or subclass methods. However, such problems are mostly not put down to semantic class fragility, which term is usually restricted to errors that, due to apparently innocuous,

[1203] See [MS97a] p. 4 et seqq. and [MS98] p. 359 et seqq. These cases correspond to the rules listed on p. 248 below. [Mikh98] discusses further problems that arise when explicit invariants are to be observed.

[1204] This example was inspired by (but not identical to) the one in [MS97a] p. 3, which, in turn, was adopted from [SLMD96].

but subtly deleterious changes in superclass code, occur in the functioning of subclass code designed so as to rely on certain implementation details of the superclass.

As an aside, it is also possible to introduce similar semantic fragility problems by the use of *delegation,* since delegation is equivalent to inheritance.[1205] Thus, we can also talk about a *semantic fragile client problem.*

2.1.1.5 Précis of Fragility Taxonomy and Concluding Remarks

The fragility taxonomy developed in the previous sections is summarised in *Figure 20.*

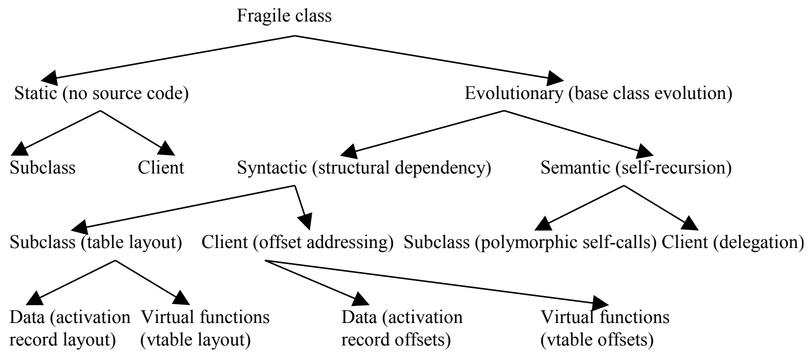

Figure 20. The fragility taxonomy. The prime cause of the problem under consideration is given within parentheses.

In order to determine how vicious the different manifestations of the fragile class problem – the semantic, the syntactic, as well as the static one – are in real-world scenarios, empirical studies are evidently needed.[1206] The liability to each of these manifestations of fragility is likely to vary a great deal between different types of object-oriented systems. For example, *Newi*-style business objects[1207] are not liable to the syntactic variant of the problem at all, which, in contrast, is a major trouble in many object-oriented programming languages. One may be inclined to believe that some of the variants of the semantic fragile class problem may not occur exceedingly often in practice, although the frequency will largely depend on patterns of usage, especially with reference to *polymorphic self-calls.*

1.2.7 CURING FRAGILITY– THE SYNTACTIC PROBLEM

Various attempts to circumvent the *syntactic fragile class problem* have been made[1208], although these will generally imply a considerable run-time or load-time performance penalty or other discomforting drawbacks. I will now examine four such approaches and, finally, propose a fifth one, which, while drawing on ideas from the surveyed ones, attempts to eschew their disadvantages.

2.1.1.6 The "Software-IC" Approach

In his readable book *Object-Oriented Programming. An Evolutionary Approach,* Brad Cox argued that *supplier-side binding* is required to bring about the *loose coupling* between supplier- and consumer-side code crucial to the

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[1205] See below p. 250. As made clear in [Szyp98a] p. 48 et seqq., kindred problems also haunt libraries that make use of callbacks.

[1206] Albeit not concerned with the fragility problems, [PD01] provides an example of such an empirical study of the effects of the use of inheritance.

[1207] See [Sims94].

[1208] The modifications that may be made to a base class without breaking its subclasses is listed in [FCDR95] p. 435 for a number of implementations of object-oriented languages.

component-based, *Software-IC* style of programming he advocated, whereas direct or indirect *consumer-side binding* inevitably creates a *tight coupling,* which will undermine any plug-and-play component vision.[1209] To facilitate the realisation of the *Software-IC* programme, Cox devised a scheme for the *Objective-C* language that does away with the *syntactic fragile class problem,* at least as far as virtual methods are concerned.[1210] His approach may be summarised in three rules:

1) All method dispatch is made dynamically at run-time *inside* the *Software-IC*.
2) During compilation, the method dispatch tables of the superclasses are not physically concatenated with that of the subclass, but instead linked to it by superclass dispatch table pointers, which are navigated during method search.
3) All instance data should be private (i.e. accessible only through accessor methods) and, hence, unaffiliated to the class interface, although this rule is not enforced by the *Objective-C* language.[1211]

Cox' scheme, which largely seems to be moulded on that of *Smalltalk-80,* may – and, indeed, should – be refined so as to remove the problem of instance data fragility as well. This could be achieved by splitting the *activation records* into a linked list of per-class records similar to the list of the method dispatch tables and searching this list for data members dynamically at run-time.

Unfortunately, run-time method (and data item) searches will be quite expensive compared to simple dispatch table lookups, in particular if the search algorithm makes use of string comparisons. In the *Newi* business object infrastructure, which has adopted an approach similar to the suggested one, this is not much of a problem, since the granularity of its business objects will assure that inter-object messaging will be a comparatively rare occurrence, primarily happening as a consequence of direct user interaction.[1212] For fine-granular objects, such as those found in programming languages, the performance penalty will be all the more discomforting. *Objective-C* actually optimises away most (but not all) of the run-time performance penalty through some ingenious sleight of hand.[1213] In *Smalltalk*, which also relies on run-time dispatch of methods, thereby

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1209 [CN91] p. 26. Cox uses the terms *consumer-side binding* and *supplier-side binding* to clarify where method dispatch is made. In a *consumer-side binding* scenario, the consumer – i.e. the code making use of a component – is responsible for selecting – typically, in a switch statement – the operation proper for the type of component at hand, whereas when *supplier-side binding* is relied upon, the component itself – i.e. the supplier – selects the proper operation upon the arrival of a message from the consumer. The latter, preferable approach implies that the consumer and supplier are decoupled from each other.

1210 See [CN91] p. 69 et seqq. and p. 137 et seqq. These ideas were first presented in [Cox86].

1211 By default, instance variables are private in *Objective-C* and must be accessed through accessor methods. Howbeit, instance variables may be made directly accessible through *C* style point notation through an *@public* declaration, which, however, is to be regarded as an optimisation technique to be used with discrimination (see [CN91] p. 101 et seq.). It should of course be shunned in classes intended to become *Software-ICs* in order to avoid *client fragility.* Additionally, the *syntactic fragile subclass problem* is not addressed at all as far as instance data are concerned and, hence, remains a problem in *Objective-C.*

1212 [Sims94] p. 277 et seqq.

1213 In *Objective-C,* every *message send,* which is the *Objective-C* locution for a "method call", is made through the *messager* function (the dots denote an unspecified number of method arguments, `id` an object reference, which is the default return type):

```
id _msg(id receiver,SEL selectorCode,…);
```

As an optimisation, the message name is transformed from a string into an application-unique number called a *selector code* "through a process that operates partially at compile time, partially at link time, and finally at startup time" and that relies on per-class initialisation functions to reconcile the *selector tables* so that all the *selector codes* will be unique and consistently used. These *selector codes* are tabulated in *selector code tables,* which are indexed by (arbitrary) compiler-generated numbers that will be unique per compilation unit. The *selector code,* in turn, is used as an index into a class-specific *selector table,* which holds the pointers to the methods of the class. Thus, an *Objective-C* message send, such as:

```
[anObject do];
```

may result in the generation of a call of the *messager* like this:

```
_msg(anObject,selectorCodeTable[53]);
```

This call implies that a new stack frame for _msg, holding a reference to the message receiver, the selector code, and, possibly, some arguments to the message send, will be allocated. This stack frame is the one expected by the target method, and, hence, control may be transferred to the method through a jump inside the `_msg` function:

avoiding method (but not data) fragility, each class has an associated message dictionary, which is accessed through a hash function.[1214] Through the use of a *method lookup cache,* the performance penalty is usually considerably alleviated.[1215]

2.1.1.7 The Java Approach

In an interview given some years ago, the *Java* designer James Gosling was asked, what kind of problems the *Java* language solves for the enterprise. In his reply, the first thing he mentioned was a well-functioning modularity, which eliminates the vexing fragile base class problem of *C++.*[1216] If we may indulge in a little nit-picking punctilio, it would have been more accurate for Gosling to say that the *Java Virtual Machine (JVM),* rather than the *Java* language *per se,* solves the fragility problem.[1217] *JVM* is a portable and – at least in principle – language-independent abstract machine in the *UNCOL (Universal Computer-Oriented Language)* tradition, of which the most well-known representative prior to *Java* will be the p-code machine of *UCSD Pascal,* although various implementations of interpreted object-oriented languages, such as *Smalltalk,* have also relied on a virtual machine scheme.[1218]

In any case, a *Java* compiler translates the *Java* source code files to *class* files, which will contain the instructions or *bytecodes* in the *JVM* format as well as a symbol table and various other pieces of data. The *bytecodes* may be directly interpreted or further compiled to native code. In case the latter course is taken, *just-in-time (JIT)* – i.e. run-time – compilation will mostly be preferred to conventional compilation in order to preserve the portability and security advantages implied by the *class* file format.[1219]

The *Java Virtual Machine* eschews the syntactic fragile base class problem by two notable strokes:[1220]

```
JMP(receiver->isa->selectorTable[selectorCode]);
```

The variable *isa* is a pointer to the class prototype of the current object (the "shared part" in Cox' terminology). The overhead of this optimised scheme compared to a function call will according to Cox be almost 2 and is caused by the table lookups. Actually, the `_msg` call could be optimised away altogether by generating code like this:

```
(*anObject->isa->selectorTable[selectorCodeTable[53]])(anObject);
```

This is not done in *Objective-C,* since it would spoil the message tracing and other facilities made possible by the intermediate `_msg` function. Furthermore, since the tables involved in the above scheme may become very bulky, Cox suggests a hashing-based mechanism that will reduce the bulk at a small performance cost (according to Cox the overhead will become approximately 2.5 instead of 2). See [CN91] p. 90 et seqq. and p. 151 et seqq. for more details.

1214 See [GR83] p. 586 et seqq. and [FCDR95] p. 435.

1215 See [CL83]. Compiled versions of *Smalltalk* usually take advantage of *in-line caching of method address,* which is to say that the method address is cached at the call location by the method lookup routine's dynamically overwriting the instruction that calls the lookup routine itself with an instruction that instead calls the target method directly. Because of *locality of type,* the cached method address will probably be the correct one, although this must of course always be checked, which is done in the entry code of the called method. In case the type of the actual receiver is not identical to the class of the cached method, the regular lookup routine will be called. This kind of *in-line caching* was first suggested in [DS84]. [HCU91] generalises this idea by saving not only the result of the latest method lookup, but the results of all lookups in a stub routine referred to as a *polymorphic inline cache (PIC).* Cf. also [USCH92] p. 54 et seqq.

1216 [Venn99]

1217 [LY99] is the specification of *JVM.* [Fran98b] criticises the *JVM* approach for lacking scalability with reference to the structural programme analysis needed for code optimisation and code verification, as the byte codes are translated into native code, and instead advocates a "tree-based representation that already encodes structural information such as control flow".

1218 See [NAJN+81], [Leca81], and [Kras83b].

1219 See [CFMS+97], who, following [DS84], argue that a method should not be compiled until it is about to be executed for the first time, since typically less than half of all methods are executed during a programme execution.

1220 See [GM96] section 5.1.

- *name resolution* is suspended to *link time,* which is to say that symbolic references will only be translated into addresses and offsets[1221] at the point of time when linking occurs
- the determination of the storage layout of objects is not done at compile-time, but is deferred to run-time

In *Java,* the *linking* of a class may take place at any time between the *loading* and the *initialization* of the class.[1222] The resolution of symbolic references into direct ones, which is the purpose of linking, is in *JVM* always combined with the process of *bytecode verification,* performed by a *bytecode verifier,* in order to detect various problems, including *version skew,* so as to be able to throw an exception before the code is actually executed, in case there should be a problem.[1223] *Version skew* may occur due to changes to the types or to the visibility (public, protected, private) of the function and data members of a class, deletion of members, and suchlike.[1224] Since linking will either happen at load time or dynamically at run-time *(lazy linking),* non-substantial modifications will never make a *Java* application break.[1225]

The cost for the dislodgement of the spectre of syntactic fragility in *Java* may be considerable in terms of run-time performance (bytecode verification, dynamic linking, and possibly dynamic compiling), and indeed the performance of *Java* programmes has repeatedly been reported to be disappointing.[1226] In particular, the same performance penalty will have to be paid afresh every time a *Java* programme is executed. On the other hand, if the *JVM* approach is abandoned for conventional compilation to native code, as is often suggested when the performance problems of *Java* are debated, the syntactic fragility problems are bound to reappear. Apparently, the cake cannot be eaten and had at the same time!

2.1.1.8 The SOM Approach

IBM's SOM (System Object Model) attempts to counter syntactic fragility by a scheme, where interface changes not affecting the *release order* of the members *introduced*[1227] by a class can be accommodated without recompilation of the clients and subclasses of this class.[1228] The *release order* is an arbitrary sequence declared by the programmer through the use of a *pragma* in an *IDL (Interface Definition Language)* file; if no *release order* has

---

[1221] In actuality, not all *Java* virtual method calls may be resolved to *vtable* offsets at link time. To be more precise, this will not be possible, when a method is invoked through an *interface* reference, in which case it will be necessary to do a time-consuming method search each time the method is called. See [LY99] section 3.11.8. Cf. also [Ages97] p. 131 et seq. This flaw results from the amalgamation of the interfaces that a class implements and inherits into a single class interface. By keeping interfaces (and classes) strictly separate, as in *COM,* run-time method searches can be avoided at the cost of – explicit or implicit – *interface negotiation.*

[1222] See [GJS96] p. 220 et seqq. and [LY99] section 2.17.3.

[1223] Id. op. section 4.9.

[1224] See [GJS96] p. 237 et seqq.

[1225] However, unexpected, erratic behaviour may still result from class evolution in some rather pathologic cases, as shown in [ESJ02].

[1226] There are of course other factors conducive to the performance problems of *Java* as well, such as its memory management and security mechanisms. In order to enhance run-time performance, *Sun's HotSpot™ Performance Engine* uses a number of different techniques, including the dynamic compilation and adaptive optimisation of the code segments (called *hot spots),* where a programme spends most execution time. See [Sun99d], [Sun02a], and http://www.javasoft.com/products/hotspot for more details. On *BEA's* recent very fast *JRockit* server-side *Java* virtual machine, see [BEA02], where it is estimated that *JVMs* typically spend 75% of their time on translation and byte code execution in clients, but only 25% in servers. Server *JVMs* instead tend to spend much time on thread handling and *I/O.* Some recent server benchmarks of different *Java* virtual machines are provided at http://www.volano.com/benchmarks.html; see also [Neff99] and [Plam99]. More benchmark results can be found at http://www.spec.org/osg/jvm98 and http://www.spec.org/osg/jbb2000, although these results are primarily concerned with how various *Java* virtual machines perform on different client and server hardware platforms.

[1227] A virtual method introduced in a base class will participate only in the *release order* of the base class, but not in that of the subclass, even in case it is overridden in the subclass. In contrast, an overridden non-virtual method will be part of the *release order* of both the base class and the subclass.

[1228] See [FCDR95], [Lau94] p. 70 et seqq., and [Hami97b] p. 35 et seqq. and p. 140 et seqq. Cf. also [IBM94b-c], [HKMT95], and [Szyp98a] p. 103. Besides *syntactic fragility, SOM* addresses many other issues, which we will not discuss here. These include cross-compiler and cross-language object interoperability, cross-machine method calls, metaclass handling, persistence, replication, etc. In practice, *SOM* has been discontinued by *IBM,* which offers its current version (3.0) as freeware without technical support. No new releases are planned. See http://www.software.ibm.com/ad/som.

been declared, the actual order of the members of the class will be defaulted to. It will be possible to add a new method or instance variable without recompiling subclasses and clients, provided the new member is appended to the *release order*. Likewise, member functions can be reordered, if the *release order* is preserved. It is also possible to delete a member, provided that it is retained in the *release order* declaration, promote it to a base class, change its accessibility, etc.[1229]

Instance data do not participate in the *release order,* but are gathered together into two separate per-class groups, one for *public* data and another for *private* and *protected* data.[1230] Data members can be added at the end of each group without recompilation of clients and subclasses, but cannot be reordered, deleted, or promoted to a base class, nor can the type, size, or accessibility of a data item be modified without recompilation.[1231]

To achieve *release-to-release binary compatibility (RRBC), SOM* relies on a run-time machinery, through which all object access and object manipulation must take place. Notably, all *SOM* objects must inherit from a special base class *SOMObject* and be created and initialised through special *SOM API* methods. The function members (and static data members) of a class are accessed through a structure `<className>ClassData`, which contains a reference to the *class object* of the class of the object as well as a table of *method tokens* sorted in the *release order* of the class. Given an object *x* that is an instance of the class `Car`, a call of the method that occupies position three in the *release order* of `Car` would be translated into something like this by a *SOM* compliant compiler:

```
CarClassData.token[3](x,__SOMEnv,…);
```

The `token` array contains the *method tokens,* and `__SOMEnv`, which is implicitly passed in all *SOM* method calls, is used for error handling purposes. A *method token* is a pointer to a function. For a static or a non-virtual method the *method token* references the target method directly, whereas for a virtual method it references a *thunk,* which is a code snippet created at run-time by *SOM*. Inside the *thunk,* the target method of the object passed as the first argument above is invoked through a *method table,* which is one of the run-time structures that *SOM* creates for each class.[1232] By the use of *thunks,* the offset resolution process for virtual methods is effectively internalised into the class that introduced the method, whereby it will be possible to add new base classes to a class hierarchy without having to recompile the subclasses. The reason why this is possible is that the release order table of a class only contains the methods introduced by this very class and, thus, is wholly unaffected by additions to the base classes. This is in contrast to common implementations of object-oriented languages such as the *vtable* layout discussed above (see *Figure 19),* which includes all the methods of a class and its superclasses in the *vtable* of the class, not just those introduced by the class itself.

There are several more or less serious drawbacks of the *SOM* approach. Firstly and most importantly, *SOM* only provides a partial solution to the syntactic fragility problems[1233] and, at that, introduces a number of nasty catches that will force the programmer to acquire a thorough understanding of its – quite intricate – inner workings. For instance, if a non-virtual method is added to a subclass and this method overrides a method in a base-class, the clients will still call the method of the base class, unless they are recompiled.[1234]

[1229] The supported (and unsupported) types of changes are listed in [Hami97b] p. 39 et seqq.

[1230] [Hami97b] p. 38

[1231] See [Hami97b] p. 43 and p. 146 et seqq. Private data members can, however, be deleted and promoted to a base class, provided that all function members of their own class and of any existing *friends* are recompiled. It is recommended that any instance data intended to be used by clients and subclasses be declared *SOM attributes,* which implies that these data members will be *private* and can be accessed from outside their own class only through special accessor methods prefixed by *_get_* and *_set_*. These accessor methods will, of course, take part in the *release order* of the class. See [Lau94] p. 32. [FCDR95] p. 435 states that instance variables may be reordered in *SOM,* although no further details are given.

[1232] The *SOM* run-time structures are quite complex, and we will have to skip the details, which are painstakingly documented in [Hami97b] p. 133 et seqq. In addition to *offset resolution* through the `<className>ClassData` structure as described above, *name-lookup resolution* and *dispatch-function resolution* are supported. *Offset resolution,* which is the most efficient resolution method, will also be the most frequently used one. See [Lau94] p. 45 et seqq.

[1233] [Hami97b] p. 43 et seq. lists some of the unsupported changes.

[1234] [Hami97b] p. 37.

Secondly, *SOM* introduces its own programming model, which involves the use of *IDL* header files and special *API* methods and pragmas and makes it necessary for all objects to inherit from *SOMObject.* Certainly, this model detracts from and clashes with the programming model of the object-oriented language itself, adds to rather than alleviates the labours of the programmer, and constitutes a source of errors and mistakes. Fortunately, these problems may largely be circumvented by the use of a *DirectToSOM (DTS)* compiler that generates the *IDL* and *SOM* specific code automatically, such as the *C++* compiler provided by *IBM* and described by Hamilton in her interesting book.[1235] Such a compiler may in fact render the use of *SOM* almost entirely transparent. For one thing, objects do not have to explicitly inherit *SOMObject,* when a *DTS* compiler is used.

Thirdly, there is a performance penalty as well.[1236] Each virtual method call will imply an extra indirection, and there is also some overhead involved in the access of the data members.

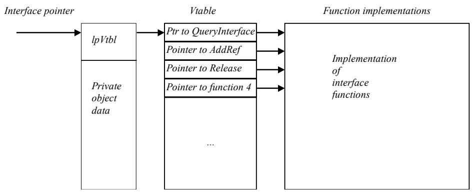

Figure 21. A COM vtable will always be laid out with the IUnknown methods first

2.1.1.9 The COM Approach

Microsoft's COM (Component Object Model) addresses syntactic fragility through the rule that *published COM* interfaces should be immutable.[1237] *COM* is based on a strict division between *interface* and *implementation* and on the capability of classes to expose multiple interfaces. Interfaces in *COM* are accessed through *interface pointers.* An interface pointer is a pointer to an object, the first element of which is a pointer to a *vtable,* i.e. a table of pointers to functions (also referred to as methods) implementing the functionality of the interface (see *Figure 19).* This mechanism is known as the *COM* binary *vtable* standard and sorts quite well with the way classes are implemented in *Microsoft's C++* compiler as well as in many other *C++* and object-oriented language implementations. Consequently, if *C++* is used, the methods of an interface are called in exactly the same way as the methods of any regular *C++* object. Obviously, there is a certain bias in *COM* towards *C++* and languages with the same *vtable* layout as *C++,* as, for instance, *Microsoft's Visual J++* implementation of *Java.*

A *COM* object is accessed by clients through one or more interfaces, which it implements. *COM* supports single interface inheritance, whereas implementation inheritance is not supported at all. Although *COM* only supports single inheritance, a *COM* object may, however, implement and expose any number of interfaces. Since these interfaces are kept strictly distinct, *COM* avoids all the nasty problems of name clashes, duplicate inheritance of the same class, etc. that haunt multiple inheritance schemes. All *COM* interfaces must inherit from the *IUnknown* interface (see *Figure 21),* which supports the basic *COM* operations for *interface negotiation* and *reference counting:*[1238]

```
interface IUnknown {
  HRESULT QueryInterface(IID &iid,void **ppv);
  ULONG   AddRef(void);
  ULONG   Release(void);
};
```

[1235] [Hami97b]. Cf. also [Hami96]. Another *C++ DTS* compiler was supplied by *Metaware.* See [Meta97].

[1236] [Hami97b] p. 123 et seq.

[1237] See, for example, [Kind97] and the *COM* specification [MD95]. *COM* encompasses a large and complex set of technologies, although we will here only be concerned with the way *COM* addresses the fragility problems. See above p. 54 et seqq. for more information on the other aspects of *COM.* For references to the vast literature on *COM,* see footnote 255 on p. 55. I will not here discuss *.NET,* the recently released new generation of *Microsoft's* component technology, which takes advantage of just-in-time compilation and a virtual machine approach similar to that of *Java.* On *.NET,* see, for example, [Chap02] and [Plat02].

[1238] The notation used here is Brockschmidt's "clean C++ style syntax" as explained in [Broc95] p. 75.

By calling `QueryInterface(iid,ppv)` with a globally unique interface identifier known as an *IID* as the first argument a client may ask a *COM* object, if it supports a certain interface – this is referred to as *interface negotiation.*[1239] If the interface queried for is implemented by the *COM* object, the constant NOERROR is returned by *QueryInterface* and a pointer to the interface is stored in the *ppv* parameter; otherwise, an error code is returned. If a client has a pointer to an interface of an object, as it always has if it knows of the object at all, *interface negotiation* is always possible, since all interfaces inherit from *IUnknown*.

Due to the interface negotiation mechanism of *QueryInterface,* versioning in *COM* is very simple: What may change between different versions of a *COM* class or component is the set of interfaces supported by the *COM* class, whereas the interfaces themselves are immutable. For example, if a method needs to be added to an interface *ISomething*, an altogether new interface *ISomething2,* accommodating the new method in addition to the methods present in *ISomething,* will have to be created. If the client of the object is to be able to make use of the new interface, it must, of course, have learnt of it in order to be able to ask for it by calling *QueryInterface* with the correct interface identifier. Clients unknowing of the new interface will not break, because they will not query for the new interface and thus will not have to bother with it at all. The new version of the class may choose to support the old interface for backward compatibility reasons, but if the interface is removed altogether from the class, its users will find out that it is no longer supported when they call *QueryInterface* and may take appropriate action.

This somewhat simplistic, but ingenious *COM* approach brings about *release-to-release binary compatibility,* but does not solve the problem of *recompilation avalanches,* since interfaces will still be liable to frequent modification during the development phase that precedes publication. Additionally, in case the *COM* component is developed in an object-oriented language, such as *C++* or *Java,* the classes used internally in the component will be unaffected by the *COM* interface immutability rule.

As is the case with *SOM, COM* sports its own programming model, which involves *IDL* declarations, special *APIs,* etc. This model does not chime very well with that of widely used programming languages, and it is to boot known to be difficult and time-consuming to learn and master. Some language implementations, such as *Microsoft's Visual J++* and *Visual Basic,* make a reasonably good job in hiding away the intricacies of *COM* programming and may be viewed as a kind of *DirectToCOM* languages.[1240]

2.1.1.10 Dynamic Linking and Compiling with Caching

The syntactic fragility problem seems to corroborate Knuth's famous statement that "premature optimization is the root of all evil".[1241] The rash and seemingly innocent use of the available knowledge of the size, layout, and offsets of a class at compilation time for the sake of efficiency ruins a property of paramount importance, viz. that of the strict "black-box" encapsulation of objects, and licentiously creates a skein of dependencies between the inner structure of objects and their clients. Evidently, Brad Cox' plea for *supplier-side binding* enshrines the truth of how objects should be accessed, at least conceptually. On the other hand, method resolution through run-time supplier-side searches is patently very inefficient.

None of the approaches treated of above seems entirely satisfactory. Firstly, an ideal solution must eschew *all* variants of syntactic fragility, address both the problem of *release-to-release binary compatibility* and that of *recompilation avalanches,* and by no means introduce any new hitches and catches. Secondly, it should not saddle programmers with new chores, such as writing *IDL* declarations or becoming privy to arcane *APIs* or a programming model entirely different from that of the programming language used. On the contrary, a solution should be compliant with the run-time systems of common object-oriented languages and, preferably, also with *Microsoft's COM* and *.NET,* which has become de facto standards for components – in fact, the only such standards in wide use. Thirdly, the solution should incur no or at most a minimal run-time performance penalty.

[1239] See above p. 56

[1240] See [Micr98η-θ], [Verb99a-b], and p. 551 below for some more details about *Microsoft's Java* implementation.

[1241] [Knut74] p. 268

The first two requirements seem to lend some credibility to the approach taken in the *Java Virtual Machine*[1242]*,* although its difficulties to meet the third requirement call for action. Distinctive features of the *virtual machine* approach, which by no means is peculiar to the *Java* language, but may be used with any problem-oriented language, are:

- *name resolution* is suspended to *link time,* which is to say that symbolic references will only be translated into addresses and offsets at the point of time when linking occurs, i.e. sometime between loading time and initialisation time
- the determination of the storage layout of objects is not done at compile-time, but is deferred to run-time

I hold that a refinement of this approach, which I would like to call *dynamic linking and compiling with caching,* would make the performance problems evanesce without re-introducing the syntactic fragility problems.

There is a fundamental clash between the requirements of the software development process and the requirements of the production environment, where the developed software is put to use. During development, the cycle time of the development process should be kept at a minimum, whereas run-time performance is of secondary significance. At this stage, syntactic fragility is a nuisance, because it necessitates time-consuming recompilations. Obviously, the *virtual machine* approach addresses the requirements of software development quite well.

In contrast, run-time performance is a paramount concern in a production environment, whereas development cycle-time is totally uninteresting. Syntactic fragility is still a major nuisance, although now the trouble is not recompilation avalanches, but the proper management of the versions of the components that are used by one or multiple applications. Evidently, the performance characteristics of the virtual machine approach as implemented in *Sun's Java Virtual Machine* or *Microsoft's Common Language Runtime* make it significantly less suitable for a production environment than for the software development process.

Dynamic linking and compiling with caching is a scheme that attempts to amend this detriment.[1243] The main points are:

- *Dynamic linking,* including *bytecode verification,* is made when an application or other self-contained software component, such as a dynamic link library, is loaded for the first time on a computer system.

- By default, bytecodes are interpreted. In order to optimise the performance of software intended for a regular release, it should, however, be possible to specify that *dynamic compiling* is to be performed, either in one fell swoop at load-time (after the dynamic linking phase) or incrementally during execution.

- The linked and verified bytecodes are cached on disk in a file and so are any snippets of binary code resulting from dynamic compilation. This file is referred to as a *cached image* and will be loaded on subsequent executions of the application, component, or library cached.

[1242] *Microsoft's COM*-based implementation of the *Java Virtual Machine* demonstrates that the requirement for compatibility with *COM* can be met, although the integration is not entirely free from rough corners. See below p. 551.

[1243] A somewhat similar caching of compiled code is made in some recent variants of *Java* intended for use in embedded systems, where the available *RAM* memory is often very limited and the luxury of memory-demanding bytecode translation cannot be afforded. For example, the *JEFF* specification [JCon01] defines a "ready-for-execution format", which allows *Java* programmes to be executed directly from static memory. However, the *JEFF* binaries will still contain symbolic names rather than addresses and offsets in order to facilitate "symbolic linking". See also [Ive03]. [SGGB99] describes a *distributed virtual machine (DVM)* architecture, where the bytecodes are verified and security-checked and then, optionally, compiled, optimised, and profiled, and, finally, cached on central servers, from which clients then download the resulting binaries or bytecodes for local execution. In this kind of architecture digital signatures may be used to ensure that clients do not execute any code that has not been properly transformed by the *DVM*.

- To each bytecode file *(class file* in *Java)* is added a *globally unique version identifier (GUVID)* by the compiler. Whenever compilation to bytecode is made, a new version identifier is generated.

- To the cached image is added an encrypted list of the *GUVIDs* of all the class files (or other kinds of bytecode files), from which it has been built.

- When an application, component, or library is about to be loaded and a cached image of it exists, the loader will check the list of *GUVIDs* in the cached image against the *GUVIDs* of the bytecode files. If the *GUVIDs* are the same, the cached image will be used. If any inconsistency is detected, either all the class files in the cached image or, preferably, only the ones affected by the changes will be re-linked and, if necessary, re-compiled.[1244]

The most conspicuous drawback of the above approach will be that the loading of a piece of software may consume considerable time the first time it is done, in particular if the dynamic link process is ensued by a full compilation. The scheme outlined is based on load-time linking, but I believe that it could easily be adapted to *lazy linking* as well in order to create the *cached image* incrementally, although I am somewhat sceptical as to whether this will really be worthwhile, considering the jerkiness of execution that will perforce result as well as the probability that the application will be executed a large number of times before re-linking will be made necessary by the introduction of a new version of some or all of its constituents.

Notwithstanding that *dynamic linking and compiling with caching* will resolve the syntactic fragility problems, it is no magic nostrum. For one thing, if a method that is used by a client or subclass is deleted, these will by necessity break. By the same token, modifications of the *signature* of a method (i.e. its name and the types of its arguments and return value) will of course cause clients and subclasses that use the method to break. In general, the *COM* rule of interface immutability should be honoured for all *published* interfaces.

1.2.8 CURING FRAGILITY – THE SEMANTIC PROBLEM

Obviously, there is no easy corrective to the troubles inflicted by the semantic fragility problems of implementation inheritance, since, in case there were, we would doubtless have known by now. More or less drastic measures may of course be taken. Some options that suggest themselves will be:

- to "discipline" implementation inheritance by the establishment of a set of "rules"
- to enforce a larger degree of *behavioural compatibility* between subclass and base class through *structural compatibility*
- to abandon implementation inheritance altogether

We will study each of these proposals in order below and, having reached the conclusion that none of them solves the problems at hand in a quite satisfactory and practically useful way, we will suggest our own solution, which we call *encapsulated inheritance:*

- to abolish polymorphic self-recursive down-calls and direct access to superclass data for *capsules,* a novel, somewhat special kind of self-contained objects or components intended specifically for reuse

2.1.1.11 "Disciplined" Inheritance

If implementation inheritance is accepted as an unalterable matter of fact, being part and parcel of the object-oriented approach, one may still attempt to steer clear of the inauspicious consequences of semantic fragility by instituting a canon of usage rules. In case these can be formalised, it may be possible to check or enforce the observance of them through some kind of tool or, even better, through a compiler. Various

[1244] In order to be able to avoid a total re-link, all call sites and references to data items will need to be recorded in the *cached image.*

proposals about how to "discipline"[1245] implementation inheritance in this way have been published, such as Lamping's type system for the specialisation interface[1246], Stata's and Guttag's *division of labor specifications*[1247], the *reuse contracts* of Steyaert et al.[1248], Edward's *representation inheritance*[1249], Mezini's *metalevel declarations,*[1250] and Ruby's and Leaven's *JML specifications* and *subclassing contracts.*[1251]

In Lamping's proposal, of which the other schemes may be regarded as variations or developments, methods are grouped on the basis of their permissible mutual call interdependencies, which are supposed to be charted by the class designer as a set of static declarations. In subclasses, methods must be overridden group by group, which is to say that if a method is overridden that itself is depended on by other methods – directly or indirectly –, all the dependent methods must also be overridden. Unfortunately, Lamping's proposal – as well as those devised by others – add considerably to the complexity of object-oriented programming by forcing programmers to understand and pay attention to method interdependencies and method groupings.

A different direction of research is represented by Mikhajlov and Sekerinski, who in a very thorough study of the "fragile base class problem" propose a set of rules for base class revision and subclass construction and set out to formally prove that the observance of these rules will make it possible to avoid the semantic fragile base class problem altogether.[1252] These rules are:

- A base class revision and an extension subclass must not introduce cycles of method invocations.
- A method in a base class revision should not make any assumptions about the behaviour of the other methods of the revision class beyond the behaviour described in the original base class.
- A method in an extension subclass should not make any assumptions about the behaviour of the other methods of the extension class beyond the behaviour described in the original base class and should not take into account that base class self-calls can be redirected to the methods of its own subclass.
- An extension subclass must not access the state of its base class directly, but only indirectly through the accessor methods of the base class.
- An extension subclass must not tie values of its instance variables to values of base class variables in order to generate an invariant.

Notably, these rules presume that all subclasses of the base class to be revised as well as the base class revisions themselves will only be "refinements" and *behavioural subtypes* of the original class.[1253] This implies that

---

[1245] The concept of *disciplined inheritance* was suggested by [Sakk89], who used the term to signify an application of inheritance that adheres to "tentative rules and restrictions that promote "better" programming". Much has been written about such rules or "heuristics"; [JF88], [Riel96] p. 75 et seqq., [Tali94a] p. 12 et seqq., and [Webs95a] p. 167 et seqq. are some prominent examples.

[1246] [Lamp93]. Cf. also [KL92] and [Hauc93].

[1247] [SG95]

[1248] See [SLMD96], [MSL96], and [HLS97].

[1249] See [Edwa97b].

[1250] [Mezi97]. Mezini and co-workers have also implemented tool support for the automatic detection of fragility problems in *Java* binaries; see [MPDB99].

[1251] [RL00]. Cf. also [Leav91], [DL96], [LD00] and [Szyp98a] p. 109 et seqq.

[1252] See [MS97a-b] and [MS98].

[1253] See [Amer87], [Amer90], [LW93a-c], [LW94], [LW99a], [BMW00], and [FLF01]. *Behavioural subtyping* is closely related, although not quite identical to the concept of *behavioural compatibility* discussed by [Wegn88] p. 61 et seqq. The so-called *Liskov substitutability principle (LSP),* mandating that a subclass should be a behavioural subtype of its base class (see [Lisk87]), is on good grounds criticised as ill-founded by [SF98]. A survey of much of the research on *behavioural subtyping* and *refinement* is provided in [LD00]. Albeit theoretically interesting, the results arrived at by the formal methods specialists active in this research area have so far been of rather limited practical usefulness as far as the fragility problems are concerned and will not need to concern us further here.

the externally observable behaviour of all the operations of derived and revised classes must remain unchanged and that no operations that cannot be reduced behaviourally to already existing ones are allowed to be added to it. These assumptions are indubitably much too restrictive for typical real world scenarios of subclassing and possibly of base class evolution as well. In addition, some of the rules cannot be adhered to, unless source code is available to subclass implementers, who, for example, will need to make themselves familiar with the self-call patterns of the base classes to be able to abide by the rules. Frequently, source code will, however, not be available, and, even in case it should be, the considerable cognitive effort implicit in the scrutiny and analysis of such code would undoubtedly place a most unwelcome burden on programmers.

2.1.1.12 Structural Compatibility

Commonly used varieties of inheritance allow the behaviour of inherited methods to be arbitrarily changed by subclasses. Additionally, in some languages, such as *Eiffel,* it is legal for a subclass to undefine methods declared in a base class.[1254] It could be argued that such freedom is bound to become abused and that more restrictive forms of inheritance are preferable, particularly in case the provider of the superclass is not in control of the subclasses and the subclass provider will not have access to the source code of the superclass. For one thing, it would seem advantageous, if the *substitutability* of a subclass for its superclass could be ensured or promoted by some clever mechanism. Conceivably, such a mechanism might also have bearings on the *semantic subclass fragility problem,* which seems to imply some kind of breakdown in the *substitutability* of a subclass for its base class.

The *Beta* programming language provides an interesting variant of inheritance, which, by supporting *structural compatibility*[1255] between subclass and superclass, will promote – although not guarantee – *behavioural compatibility.*[1256] The concept of "complete behavioural compatibility", which is necessary to guarantee the *substitutability* of a subclass for its superclass, is defined thus by Wegner: "A subtype is completely compatible with its supertype if it has the same domain as the supertype and, for all operations of the supertype, corresponding arguments yield corresponding results".[1257] Other weaker kinds of compatibility exist, such as *signature compatibility,* which preserves the signatures, but not the behaviour of the operations of the supertype in the subtype, and *name compatibility,* which only preserves the names of the operations.[1258]

In contrast to most other languages, *Beta* does method resolution in a top-down manner, starting the search for a method from the root base class and proceeding downwards the class hierarchy, until the method searched for is found.[1259] Significantly, a virtual method of a superclass will not be *replaced* by a homonymous subclass method, but, in order to preserve *structural compatibility,* it will be *combined* with all its namesakes in the subclasses. Method combination will happen in the following way: The execution of the topmost superclass method starts from the beginning of this method and continues, until the keyword *inner* is lit upon, at which point control is transferred to the next homonymous method downwards the class hierarchy. When this subclass method comes across an occurrence of *inner,* it will, in turn, transfer control to the next subclass method, and so on. Whenever the end of a method is reached, control will be returned to the proximate superclass method, which will continue its execution at the instruction that follows immediately upon *inner*. The *inner* key-

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[1254] [Meye97] p. 552. In *C++,* a similar effect can be achieved by making the method *private* in the subclass. Cf. also [Snyd86].

[1255] [LM89] p. 398.

[1256] See [LMN93] p. 109 et seqq. Cf. also [BLMN87].

[1257] See [Wegn88] p. 61 et seqq. Cf. also [Lisk87] and [BarD92]. The kind of inheritance compliant with Wegner's substitutability definition is often referred to as *behavioural inheritance.* According to [LP91], such "subtyping" inheritance should be distinguished both from the modelling construct of specialisation ("is-a") and the implementation method of "subclassing" (i.e. implementation inheritance).

[1258] *Signature compatibility* may be somewhat relaxed by various rules of *covariance* and *contravariance,* such as those proposed by [Card88b]. Surveys of the much-debated *covariance/contravariance* issue may be found in [Szyp98a] p. 79 et seqq., [Meye97] p. 621 et seqq., and [Cast95]. Compatibility may be further weakened by allowing *cancellation* of operations in subtypes.

[1259] *Beta* actually combines methods and classes into one concept called a *pattern.* Not to confuse the reader, I will, however, not use this term.

word may occur more than once in a method, in which case control will be transferred to the beginning of the same subclass method at each of these occurrences.[1260]

Obviously, *structural compatibility* makes it difficult to change the behaviour of a class arbitrarily, although it will still be possible to augment it at well-defined slots. Whereas this should reduce the risk of introducing erratic behaviour that makes superclasses break, writing programme code with method combination in mind will hardly be possible without access to the source code of all the methods involved. In addition, the "down-calls" made during method combination are instances of the very kind of polymorphic self-messaging that is at the root of the fragility problems, as explained above. Thus, if a new inheritance model that extirpates the *semantic fragile class problem* is what is searched for, the idea of enhancing behavioural compatibility through *structural compatibility* is clearly a cul-de-sac.

2.1.1.13 Abandoning Implementation Inheritance

In *Microsoft's COM,* the currently most widely used commercial component infrastructure, the semantic and static fragile class problems are avoided through the abandonment of *implementation inheritance,* whereas syntactic fragility is dispelled by declaring all published interfaces immutable, as explained above.[1261] Notably, *hierarchical modelling,* which is often claimed to be the most commendable way of using inheritance, remains possible, since *COM* does support *interface inheritance.*

Instead of implementation inheritance, *object composition* may be taken advantage of as an extension mechanism. When composition is relied upon, an *outer object,* corresponding to the subclass, will *forward* all or some of the messages it receives to an *inner object,* which matches the superclass. In *COM,* such a simplistic forwarding scheme is referred to as *containment* or *delegation.* One *COM* object, the *inner object,* is, as it were, contained in another *COM* object, the *outer object,* and the outer object exposes and implements the same interfaces as the inner one – and possibly other interfaces as well, of course. Often, each method of the delegated interfaces of the outer object is implemented as a simple forward call of the corresponding method of the inner one, although it is perfectly possible for the delegating method to do any supplementary processing before or after the forward call – or not to forward the call at all.

If the outer object passes a reference to itself to the inner object and the inner object uses this so as to adjust any references to *this* from itself to the outer object, the outer object is, in the patois of the research-oriented and technical object-oriented literature, said to *delegate* messages to the inner one. In *COM,* a variant of this scheme called *aggregation* can be used instead of *containment/delegation* (i.e. simple forwarding).[1262] By its use, the drudgery of duplicating interfaces and writing forwarding code is avoided and a small performance improvement may be experienced to boot, since aggregation makes it possible to directly expose the interfaces of the inner object to clients by virtue of the interface negotiation mechanism *(IUnknown::QueryInterface)* of *COM.* While conceptually elegant, aggregation is, however, considerably disfigured by a number of sombre complications, which has made its use considerably less popular than one might *prima facie* expect.[1263] Ad-

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[1260] One may think that it should be possible to call different subclass methods at different *inner* locations. In this case, the names of these methods would have to differ from each other as well as from that of the superclass method. In essence, this would be equivalent to calling a number of pure virtual functions, the implementation of which is deferred to subclasses.

[1261] For a number of reasons divulged in [RL89], a similar approach was taken in the *Emerald* language. Likewise the component-oriented *Lagoona* language relies on forwarding and composition instead of inheritance, as explained in [FF01], [Fröh02], and [FGF02]. Also [WZ96], [Weck97], and [Szyp98a] p. 117 et seqq. are critical of inheritance and advocate object composition as an alternative. In the context of the *Java* language, [BSZ02] suggest that inheritance should be allowed only within a *Java package,* but not across packages. Such *class sealing* implies a form of polymorphism called *oligomorphism,* which restricts the set of subclasses to the ones known at compile-time, thereby, it is argued, making for better optimisation, encapsulation, and security. Cf. also [BGP01].

[1262] It should be noted that the usage of the term *aggregation* in *COM* differs from the meaning usually attached to it in object-oriented analysis and design, where the concept of *aggregation* is used to signify a part-of relation in contrast to the looser forms of relations between objects referred to as *associations.* See e.g. [RBPE+91] p. 57 et seq. [BW00] provides an interesting development of the idea of aggregation.

[1263] Since these snags, which concern the lifetime control of the inner objects and some other minutiae, are rather arcane in nature, we refer the interested reader to [Broc95] p. 103 et seqq.

ditionally, *delegation* has been shown to be equivalent to class inheritance and will, consequently, reintroduce all its problems.[1264]

If we – like the *COM* designers – believe that the semantic – and static – fragile base class problems are potentially fatal to systems built from independently evolving binary components, it may seem reasonable, although admittedly somewhat drastic, to pinion object-orientation by giving up implementation inheritance. Nevertheless, it is awkward to have to write a large number of forwarding methods, if all we want to do is to add or modify a single or a few methods. Nor does the complexity of the aggregation mechanism of *COM* look very inviting, in particular as it resuscitates the very same fragility problems that were to be evaded by the abandonment of implementation inheritance!

2.1.1.14 Encapsulated Inheritance

Instead of giving up implementation inheritance as a mechanism for incremental modification and extension altogether, I should like to suggest a middle course. In my view, the starting point for the needed re-design and reformation of implementation inheritance should not be the animistic outlook of object-orientation, but rather the mechanistic perspective of software components, component markets, and software engineering and the requirements that follow from this perspective.[1265] Below, I will outline and discuss a proposal for a reformed inheritance mechanism, *encapsulated inheritance,* designed for a novel component type, which I will call a *capsule* in what follows.

A *capsule,* albeit not adhering to the traditional object-oriented model, will not rule out the use of object-oriented programming languages, but will rather play a rôle similar to a *COM, .NET,* or *JavaBeans* component. In fact, it may be understood as a kind of compromise between the approaches taken in *COM* and *.NET/JavaBeans*, being in effect a somewhat component-oriented *object* or, viewed from another point of view, a somewhat object-oriented *component*. Being a special kind of object, it may, perhaps, even one day be supported directly by *encapsulated programming* languages, which I envision as closely akin to object-oriented languages and which, thus, most likely will also provide support for traditional *objects* in addition to *capsules*. Notably, the notion of a *capsule* is distinct from and should not be confused with such concepts as *modules* or *packages,* as there can be many run-time instances (capsule objects) of a capsule just as there can be many instances (objects) of an object-oriented class.[1266]

For software components, *encapsulation,* or rather *black-box encapsulation,* will be imperative, and, thus, the novel form of inheritance we are about to frame must support this concept fully and wholly, i.e. it must be genuinely *encapsulated inheritance,* preserving the appearance of the component as a *black box*. True *encapsulation* rests on two important principles:

- *information hiding,* which implies that implementation details, concerning e.g. how data are represented and behaviour implemented, should not be visible or accessible from the outside[1267]

- *self-containedness,* which implies that the component or capsule should itself, in some sense, contain and enclose everything it needs for servicing its ends, whatever these may be

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[1264] Vide [Stei87], [Mikh98], and [Szyp98a] p. 119.

[1265] See [Card96] for a brief and insightful critique of various aspects of object-oriented languages from a software engineering perspective. Many of the topics broached in this paper are also touched upon in the current study.

[1266] The seminal paper on modules will be [Parn72], whereas the most well-known and thoroughgoing implementation of the concept will be that of the *Modula-2* language (see [Asto86]). Much has been written on the relation of modules and objects – see, for example, [Snyd86], [Leav91], [Szyp92], [BL92], [SG95], [FF98], [Fröh00], [FF01], and [AZ01]. It is now widely recognised that *modules,* which are *compile-time abstractions* with no meaning at run-time, are orthogonal to *classes,* which, in contrast, are *run-time abstractions,* as they define the layout and behaviour of objects at run-time (so [Szyp92]). By the same reasoning, *modules* and *components* will also be orthogonal, although this does not seem to be as widely recognised. *Packages* as implemented in *Ada* and *Java* are broadly similar to modules.

[1267] See [PCW83]

The former principle motivates strict adherence to the discipline of *data abstraction.* In this context, this will mean that all data members must be private and accessible to clients and subclasses only through *accessor* methods. Thus, the *public* and *protected* data members of *C++* and *Java* will be anathema for a capsule. Another corollary of the principle of *information hiding* will be that the programmer by no means should need access to the source code in order to use a class or to modify it through subclassing. Thus, the cessation of the *semantic fragile subclass problem* will be a *sine qua non.*

According to the principle of *self-containedness,* only code being part of and encapsulated by a component should be relied upon inside the component. Hence, reliance on callback functions for the implementation of the behaviour of a component is ruled out.[1268] This renders the *polymorphic self-call* suspect, insofar as such a call will possibly be resolved into an invocation of a subclass method, i.e. a *down-call,* which really is nothing but a special, object-oriented form of callback. In particular, if the interface of a component, as is often claimed, is to be understood as a contract,[1269] it seems odd that the party responsible for the implementation of this contract should defer parts of its implementation to methods of which it has no control whatsoever and the validity of which it cannot ascertain. The use of other capsules, components, and objects *inside* the primary component is not ruled out by the principle of *self-containedness*, provided that these are encapsulated by the primary component and can be tested and delivered together with and as parts of it.[1270]

To ensure compliance with the principle of *self-containedness,* it appears that the passing of object references as well as function and method pointers or *C#*-style delegates as method arguments across capsule boundaries cannot be brooked. However, the enforcement of such a dour regimen would probably be too restrictive for many practical purposes and will in any case not be necessary to come to terms with the *semantic fragile subclass problem.* In our contention, there will indeed be some cases where the use of callback arguments will be both valuable and valid, although this technique should be used only with the greatest restraint and care. Firstly, there are some kinds of callbacks, which do not imply that the component is made to depend on extraneous code for its own behaviour. These will include calls of the accessor methods of an object passed as an argument to one of its methods[1271] as well as of any event notification callbacks registered with the component.[1272] Secondly, every component or capsule will need to interact with its container according to a precisely defined and, hopefully, harmless protocol established by the component standard adhered to. Thirdly, one may want to allow a capsule to be configured at certain "hot-spots" by an object, capsule, delegate, or callback function that adheres to a well-defined and meticulously specified protocol.[1273] In this case, the component itself should provide sensible default behaviour and, possibly, a selection of differently implemented objects or callbacks, from which the user may pick anyone that corresponds to his needs and liking. If the user is also allowed to pass callback behaviour of his own making to the component for such configuration purposes, *self-containedness* will indeed be compromised, although this will happen in a more controlled way

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[1268] See [Szyp98a] p. 57 et seqq. and [MSL99] for a discussion of the problems caused by callbacks.

[1269] So, for instance, in the influential definition set down in [SP96] p. 4 and in [Szyp98a] p. 44 et seqq. On contracts, see [HHG90] and [Meye92]. In some programming languages, such as Eiffel (see [Meye97] p. 331 et seqq.), a kind of elementary contracts is supported through the option to declare pre- and post-conditions and perhaps invariants for methods. In principle, contracts can be made to cover many other kinds of conditions and requirements, albeit certainly only at the cost of considerable complexity. A miscellany of papers on contracts can be found at http://people.cs.uchicago.edu/~robby/contract-reading-list.

[1270] Cf. the plea for "modular reasoning" in [SG95].

[1271] Alternatively, one may consider only allowing arguments of primitive types – and possibly capsule references – to be passed to and from capsule methods, thereby forcing the caller to handle the extraction of the needed data from the objects concerned before a call and the insertion of any returned results into them after the call. Such an approach may, however, not sort well with purist object-oriented languages where primitive types are not distinguished from classes. Additionally, event registration and container interaction methods can hardly dispense with object references. Since such methods are somewhat anomalous anyway, it seems preferable if they are not part of the capsule interface implemented by the capsule programmer, but are automatically – and safely – provided by the capsule infrastructure and/or language.

[1272] This does not mean that such notifications are always innocent. For example, an event handler may make callbacks on the object that issued the event notification in the first place, thereby causing nasty self-recursion problems of the kind amply exemplified in [Szyp98a]. Evidently, a strict regulation as to what is permissible in an event handler is called for. Perhaps, the only kind of self-recursive calls to be allowed here are getter accessor methods. In addition, a subclass should not be permitted to register for event notifications from its superclass in order to avoid the creation of invariants between subclass and superclass instance variables (see p. 248 above).

[1273] See footnote 1280 on p. 255.

than is common in today's object-oriented programming style. Whether such freedom should be permitted or not, is a question that falls outside the scope of the current study.

Furthermore, although it has for some time been known that polymorphic self-calls is the cause of the *semantic fragile subclass problem,* the attempts to make implementation inheritance more well-behaved have by all means striven to preserve inheritance as it has come down to us, including the polymorphic self-calls that are at the very root of the evils to be cured, or have even, due to the focus on *behavioural compatibility,* attempted to develop it in a direction that in fact may exacerbate the fragility problems. It has, however, become evident that if the fragility problems are to be evicted such preservation will be possible only through overly complex and practically unusable schemes or canons of rules. Thus, the stark alternatives of either abandoning implementation inheritance altogether – adopted by *COM* – or blinking the fragility problems – as in *.NET* and *JavaBeans* – seem to be the only practically useful ones presenting themselves currently.[1274]

However, by reforming the inheritance mechanism a little, it will, I contend, be possible both to provide support for much of the versatile extensibility of implementation inheritance and to meet the requirement of *self-contained encapsulation,* liberated from the odious *semantic fragile subclass problem.* The crucial step to achieve this goal consists in the removal of the possibility to send polymorphic messages[1275] to *self* that eventuate in down-calls (i.e. *polymorphic self-recursive down-calls),* which is to say that all self-calls – polymorphic as well as static – must be statically resolved. Thus, when a self-call is issued, the search for the target method should always start in the class, from which the self-call was made and continue upwards in the class hierarchy.[1276] Notably, this scheme will be easy to implement efficiently, as the method search can be performed at compile-time.

Although polymorphism is thus removed from the specialisation interface, it remains a feature of the client interface. This implies that a call of a method of an object may be dispatched to different methods depending upon whether the caller is an external client or one of the methods of the object. This may seem peculiar, but corresponds to the semantics of containment, which is what we want to emulate. When containment is relied upon, calls of a method issued inside the inner object – which corresponds to the superclass – will always be dispatched to a method in the inner object itself, whereas calls issued from a client will always be dispatched to the outer object and possibly be overridden by it, in case the call is not just forwarded to the inner object.

That such a divergence in the behaviour exposed by the client and the specialisation interface may indeed give rise to curious effects will become clear if one considers a class that implements a visual widget and also includes a *refresh* method to update its visual appearance. If this class is subclassed and its *refresh* method overridden, a *refresh* call issued from one of the methods of the original class would – against expectation – cause the original, unmodified widget to be painted, whereas a *refresh* issued from one of the methods of the subclass or from a client would cause the modified version of the widget to be painted, which would probably be what a subclass designer would expect to happen in both cases.

In order to prevent such wayward behaviour, *implementation methods* (i.e. directly or indirectly self-called methods) should arguably be separated from the methods that are part of the *interface* of a capsule class. This can easily be achieved by restricting the accessibility of such methods to the current capsule class, i.e. by making them *private.* If support for non-overridable methods is available, as is the case in the *Java* language, one may alternatively consider the somewhat less radical step of making polymorphically self-called methods non-overridable *(final* in *Java).*[1277] In either way, a possibly confusing disagreement of behaviour between the *client* and the *specialisation* interfaces is avoided – with or without the implementation methods' becoming inaccessible to clients, respectively. In sum, the desirable semantics can be brought about by allowing self-calls only of methods that are non-*virtual, final,* or *private,* which is to say that self-calls of *virtual* methods that are neither

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[1274] The *class sealing* scheme discussed in [BSZ02] provides a kind of compromise between these antipodes, giving up inheritance across components (or rather *packages),* while preserving it internally. See footnote 1261 on p. 250 above.

[1275] It should be noted that calling a virtual function member in a specific class (X::A notation in *C++)* is not a polymorphic call.

[1276] *Prima facie,* the alternative of starting the method search from the class that is the static qualification of the object at hand may also seem worthy of consideration, but this would probably appear counter-intuitive to most of us.

[1277] Cf. [AG97] p. 71.

final, nor *private* will be interdicted. By supporting this simple rule, capsules would also automatically have exorcised direct *polymorphic self-recursive down-calls* from themselves.

In conclusion, we suggest that the term *encapsulated inheritance* should be used to signify a special kind of restricted *implementation inheritance* characterised by the rejection of:

- direct access of superclass data members from subclasses
- polymorphic self-recursive down-calls

Although these rules may be applied as design guidelines, when object-oriented programming languages are used, a stricter enforcement through direct language support for *capsules,* i.e. objects that directly support the notion of *encapsulated inheritance,* would probably be preferable. In addition, in a well-designed capsule language or system, one should consider augmenting these strictures by disallowing:

- direct access of data members from clients
- polymorphic self-calls of methods that are neither *final,* nor *private* (which also automatically debars *polymorphic self-recursive down-calls!)*

The above rules, albeit deceptively simple, are not altogether easy to enforce rigorously. For one thing, polymorphic self-calls may be indirect, taking place through the intermediation of any number of *virtual* as well as non-*virtual* methods in other classes. Thus, a "smart" programmer can easily circumvent the abolition of easily detectable *direct* polymorphic self-recursive down-calls by doing these calls indirectly through a proxy class. It will of course also be possible to cause such indirect self-recursion inadvertently by an outgoing call that ends up in a callback of the current object. Due to polymorphism, it may be very hard to detect such indirect self-calls, as in the general case it will be impossible to make a complete analysis of all possible indirect self-recursion patterns at compile or link time and also quite a daunting task to do so at run-time. If, for example, a parameter of type *Object* is passed as an argument to one of the methods of a capsule object and in this method the virtual method *Object.doSomething* is called, this call may at execution time be resolved into a call of the corresponding method in any subclass of *Object,* such as *Car.doSomething* or *Invoice.doSomething,* which methods may not even have been accessible for inspection when the capsule was compiled and linked. However, since capsules, in contrast to objects, are supposed to be self-contained and, thus, should not rely on extraneous code for their own behaviour, such outgoing calls will not be brooked in capsules at all, except in the special, usually innocuous cases mentioned above (accessor methods, event notification, container interaction, and, possibly, "hot spot" modification). Self-recursion within the capsule, i.e. calls from the capsule methods of methods on objects, which are declared inside the capsule as instance or global[1278] variables, and end up in a callback on the capsule, can easily be caught by a "smart linker", when the capsule is linked.[1279]

It may also make sense to let capsule methods – or at least *virtual* methods – be *final* by default or, better still, to substitute for the *final* keyword a new keyword *overridable,* with which the programmer would then have to explicitly mark any capsule methods apt for overriding in a subclass. Such a change from object-oriented practice may seem purely cosmetic, but really implies a reversal in outlook from animism to mechanism or, to put it differently, from white-box hierarchical modelling to black-box composition, pushing, or at least cajoling, the programmer into considering fragility problems, of which he would otherwise perhaps not even be aware. In an *encapsulated programming* language it should of course not be possible to call such an overridable method from the capsule, to which it belongs.

2.1.1.15 Consequences of Encapsulated Inheritance

While the abandonment of *polymorphic self-calls* appears necessary from the coign of vantage of software componentry, the question as to how encapsulated programming would compare to object-oriented programming, as we presently know it, certainly also deserves attention. Firstly, we should observe that *within* a

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1278 Such global variables should of course not be visible outside the capsule.

1279 Most probably, the capsule will end up as some kind of *DLL*.

capsule traditional object-oriented programming may well be relied upon, so the difference will only be perceived at the capsule level, i.e. the level where the *reuse* of components and objects is interesting. What must here be given up in encapsulated programming? Obviously, *polymorphic self-calls* are quite fundamental to at least some flavours of object-oriented programming. For one thing, it is the very sap of *object-oriented white-box frameworks,* a characteristic of which is the *inversion of control,* pithily epitomised by the so-called *Hollywood principle:* "Don't call us, we'll call you."[1280] As suggested by this saw, an object-oriented framework typically will be extended by a user through implementation inheritance, and the methods of the user-provided subclasses will then be invoked from the framework superclasses through polymorphic down-calls.

Although it will not be possible to argue this point at the proper length and depth here, I firmly believe that *white-box frameworks* have caused a fair share of the tribulations that formed the backdrop of the incipient exodus from object-oriented to component-based development in the mid-90s.[1281] Hence, I also contend that giving up *white-box frameworks* will not be a deplorable loss, but will actually benefit programming, at least in the long run.

Admittedly, *object-oriented application frameworks* command a considerable allure through the promise of massive reuse, but, unfortunately, they also fall foul of some of the more well-established and well-founded tenets of software engineering, paying due allegiance neither to the discipline of strict *information hiding* and *encapsulation*[1282], nor to the principles of minimisation of *coupling* and maximisation of *cohesion.*[1283] For this very reason, frameworks also add their own mix of bitters to the witches' brew commonly referred to as the "software crisis" – bitters that will possibly even outdo those caused by class fragility. In particular, these tend to engender the grave problems of *entangling* and *programming complexity*[1284], from which low productivity – jeopardising both the time-to-market and the functionality of the end-products – and failed or severely delayed projects regularly result.

As for *entangling,* the way frameworks operate through a kind of across-the-board structural reuse primarily based on implementation inheritance results in a very inadequate encapsulation of the functionality of the framework. Consequently, the application code will become very tightly coupled to the framework, not to say totally enmeshed in it, making it exceedingly difficult or outright impossible to exchange a framework for another or combine pieces from different frameworks – this last phenomenon is often referred to by the term *architectural mismatch.*[1285] The resulting unmitigated dependency on a single product and its – possibly small and financially shaky – supplier is well known to be extremely risky from a business point of view and can hardly be justified except in very special cases. The alternative of in-house development of the frameworks needed

[1280] The distinction between *white-box* and *black-box frameworks* was first made by Johnson and Foote in [JF88]. The user of a *white-box framework* will primarily employ subclassing and inversion of control for customisation. In contrast, *black-box frameworks,* which rely upon *composition* and *forwarding* for extension, are customised through "components", which are supplied to them by clients as method arguments. These "components" implement the application-specific functionality in keeping with a *protocol* defined by the framework. Consequently, to use a black-box framework the programmer does not have to understand its innards, but only the protocol used to interact with it from the outside through a well-defined interface. The black-box framework may even offer an assortment of ready-made components for commonly occurring usage cases, from which the programmer may choose one in order to avoid writing any code at all. In any case, subclassing and the *Hollywood principle* will be absent from a genuine *black-box framework,* which will be more like a class or module library that can be parameterised at certain *hot spots* or points of variation (see [Pree95] p. 228 et seqq.). Although Johnson and Foote exemplify black-box components with the pluggable views of *Smalltalk's MVC (Model-View-Controller)* framework, where, for example, menus may be handed over to the controller as "pluggable component" parameters, and suggest that white-box frameworks should evolve towards black-box ones, it is neither easy to find pure *black-box frameworks* in wide use, nor is it clear how these differ from ordinary class libraries. Additionally, in many frameworks the *white-box* and *black-box* styles of reuse will be mixed, and, thus, the division line between the two corresponding types of frameworks will be far from clear-cut.

[1281] [BMMB99] and [MB97a] provide an interesting and disenchanting investigation of the problems involved. Cf. also [Matt00] and the criticisms aired in [Fran98a].

[1282] See [Parn71], [Parn72], [Parn79], [PCW83], and [Snyd86].

[1283] *Coupling* is a measure of the degree of (undesirable) interdependence between software components. The term has been used since the heyday of structured design and is usually contrasted to *cohesion,* a measure of the degree of (desirable) association between the elements inside a module or component (see e.g. [SMC74] or [DeMa79] p. 308 et seq.). Cf. also [Sims94] p. 138 et seq. [HCG96] and [Booc94] p. 136 discuss *coupling* and *cohesion* from an object-oriented perspective.

[1284] I use the term *programming complexity* for lack of a better alternative. This concept is related to the quality attributes *buildability, modifiability,* and *maintainability* discussed in [BCK98] p. 82 et seqq.

[1285] See [GAO95].

may admittedly allay the risks a little, but will often be unfeasible, because of the considerable investments in time and money required for such endeavours.

Although the popular *Java* and *.NET* frameworks may not be encumbered by the aforementioned business risks or the costs of in-house framework development, these staggeringly complex congeries of general-purpose software certainly compound rather than alleviate the problem of *programming complexity* typical of the framework-based approach, a problem which tends to render object-oriented development efforts both arduous and dilatory in nature. This *programming complexity* primarily follows from the fact that application frameworks have an extremely large *surface area*[1286] and, hence, place a severe *cognitive strain* on their users, who will need large amounts of both time and talent to be able to attain the necessary mastery of these recalcitrant behemoths.[1287] Too often, the complexities of framework-based programming tend to undermine both the productivity of the programmers and the maintainability of the code they produce. This contrasts starkly to the impressive productivity, learnability, and maintainability characteristics of modern component-based *RAD* development environments.

In addition to frameworks, *design patterns* provide a popular tool in object-oriented development. Obviously, the corpus of design patterns will need to be checked through for compatibility with encapsulated programming, and alternative patterns worked out where necessary. For instance, among the design patterns presented in the seminal book by Gamma, Helm, Johnson, and Vlissides the *template method* pattern relies critically on *polymorphic down-calls;* in fact, the *template method* is the *Hollywood principle* couched as a design pattern.[1288] Whereas this pattern appears as one of the niftier artifices of the object-oriented repertoire, its disappearance would hardly affect run-of-the-mill object-oriented programming very seriously, and trading elegant subtlety for safety may make sense anyway.[1289]

Besides the *semantic fragile base class problem, encapsulated inheritance* eliminates or alleviates a few other difficulties of implementation inheritance. Firstly, the encapsulation break implicit in traditional inheritance of course disappears, and, most importantly, there will be no need for source code access when using inheritance any more than when taking advantage of containment or library calls. Secondly, the *yoyo problem* will also be much alleviated, which will make for easier debugging and run-time programme analysis.

Finally, we will also want to examine how *encapsulated inheritance* compares to ordinary containment. Albeit making a superclass and its subclasses share a common self, *encapsulated inheritance* is roughly equivalent to containment and just as unencumbered with the semantic fragility problems that haunt traditional implementation inheritance. However, the awkward forward calls needed, when containment is used, are done away with, which will liberate programmers from tedious rote work and enhance performance a little at that. Since support for up-calls will be retained, it will be possible to call methods of a superclass – the equivalent of the "inner object" in a containment relation – without explicit referencing. Additionally, polymorphism will remain a versatile feature of the client interface, and there will be no need to address the complexities of *COM*-style aggregation. In our view, software componentry à la *COM* would have gained much by adding sup-

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1286 Surface area is defined by [CN91] p. 17 as the number of things that must be understood and properly dealt with for one programmer's code to function correctly in combination with another's.

1287 During my years in software development and consulting, I saw many examples of how skilled and experienced programmers became more or less paralysed at the encounter with object-oriented technology in general and application frameworks in particular. There is a tendency amongst technology enthusiasts and academic computer scientists alike to nourish unrealistic expectations about the devotion of programmers to their trade (in the case of the academics possibly fomented by the unbridled enthusiasm that tends to go with the hacker mentality of some of their students) as well as about their intellectual capacities and education. The typical real-world programmer is neither a computing *Übermensch,* nor a die-hard hacker willing to spend all his time at the computer screen, but rather an ordinary family man of moderate intelligence and often not very well educated for a profession, in which he may not take a deep or eager interest. And, *mirabile dictu,* even the hackers tend to grow old and become involved in family life and other such adiaphora. Programming languages, tools, and methods that do not take human frailty into account will in the end never become very successful. [Dijk89] provides a scintillating, although somewhat maggoty, example of the academic strain of such intellectualism, as do some remarks in [Dijk68].

1288 Cf. [GHJV94] p. 325 et seqq.

1289 Additionally, a somewhat less noxious black-box approach may be substituted for the perilous white-box scheme of the *template method* pattern by taking advantage of a "hot-spot" configuration scheme, where, instead of making polymorphic down-calls, the configurable class invokes the methods of a configuration capsule or object passed as a method argument. In this case, both the configurable and the configuration capsule should take pains to abide by a well-specified configuration protocol exempt from any self-recursion problems. See above p. 252 and footnote 1280 on p. 255.

port for encapsulated inheritance, although it would perhaps in practice have been difficult to foist such support as an afterthought into the well-established programming model founded on the *vtable* standard. With the new *.NET* component model, *Microsoft* has, however, instead chosen to embrace the object-oriented paradigm in its entirety together with all its rough and fragile corners. In contrast, *encapsulated programming* is an attempt to find a middle course between the component-oriented *COM* and the object-oriented *.NET* and *JavaBeans* approach. Notably, its principles may be used as design guidelines when using such basically object-oriented technologies for the manufacture of reusable, marketable software components.

2.1.1.16 Encapsulated Inheritance and Realistic Computing

As for our special area of concern in this study, that is to say *Newi*-style business objects, the problem of semantic fragility will be much less pronounced than in object-oriented programming in general, as business objects will generally be designed as well-encapsulated, self-contained, independently executable high-level objects, relying on no other business objects for the services they provide. Additionally, such business objects rigorously abide by the rules of data abstraction, exposing their data neither to clients, nor to subclasses. On the other hand, they are not exempt from semantic fragility problems altogether, as indeed they are capable of sending polymorphic messages to themselves directly or indirectly, which in rare cases may indeed cause semantic fragility problems to occur. By adhering to the rules of encapsulated programming given above and, in particular, by removing the possibility of sending messages to *Self,* it should be possible to reduce these problems to insignificance. As pointed out earlier, *Newi*-style business objects are not liable at all to the syntactic class fragility problems, as they rely on semantic messaging rather than on direct method calls for their interactions.

1.2.9 CONCLUSIONS

Within the ambit of computing and computer software, I have traced the workings of the two potent metaphors of the *machine* and the *world,* to which correspond the outlooks I referred to as *mechanism* and *animism.* Whereas the *component* concept rests on the *machine metaphor,* i.e. a conception of a computer programme as a device built from a set of smaller machines conceived of as *black boxes,* which, in turn, will be built from even smaller black boxes, and so on, similarly to the way a car, an aeroplane, or most industrially produced artefacts are built, concepts such as *object* and *agent* spring from the *world metaphor,* i.e. a view of the computer or a computer programme as a small world, a microcosm, which in it accommodates a population of “things” and/or “organisms”, where we may understand *agents* as the impersonators of the “organisms” and *objects* of the “things”. It should be noted that the two metaphors are not exclusive – an *object* (or an *agent)* may be built from *components,* and these *components* may, in turn, be built from *objects.*

Arguably, the *world metaphor* will best fit in with the higher echelons of the architectural hierarchy of software that unfolds inside the computer and will sort particularly well with its topmost level – i.e. the level of direct end-user interaction, manipulation, and composition – inasmuch as modern user interfaces usually attempt to make themselves intelligible to their users through a complex fabric of more or less realistic and more or less sophisticated metaphors, which presuppose some kind of *world metaphor* as a unifying and undergirding entourage.[1290] I also believe that this appropriateness will become increasingly more obvious and marked, if the computer is equipped with a 3-D user interface and evolves into a realistic 3-D microworld, a development which may now be imminent as a consequence of the ongoing revolution of 3-D hardware performance.[1291] On the other hand, the *machine metaphor* seems much better suited for the lower-level task of constructing software from the ground up, providing a fitting basic metaphor for the creation and assembly of the viscera of software rather than for the formation of the user-intelligible and user-friendly outer appearances of directly manipulable software end-products.

[1290] The inspiration for this line of reasoning is of course the *business objects* vision promulgated by Oliver Sims in e.g. [Sims94] and [ES98] and treated of above on p 142. The concept of the “levels of integration” or “architectural levels” of software was originally excogitated by Brad Cox. See above p. 42 and [Cox90a-b], [Cox91], [CN91] p. 49 et seqq., and [Cox96] p. 75 et seqq.

[1291] See [Pers99c] and [Pers00] and the next section of this chapter.

From the vantage point of such an analysis, the *objects* of *object-oriented programming* appear as rather oxymoronic, being located, as it were, at the wrong level in the hierarchy of software inside the computer.[1292] Indeed, the various problems accompanying *object-oriented programming* may foment this surmise of inappropriateness, although I will not try to drive this point home now. In this study, my objective has rather been to cast some light on the question whether a new unified programming style can be forged that, as it were, effects a synthesis of the thesis of object-orientation and the antithesis of component-orientation, of the animistic white-box and the mechanistic black-box approaches. Indeed, an attempt to adumbrate along which lines such a synthesis can be achieved has been provided above.

To many of us, inheritance has come to loom large as the Gadarene cliff, over which object-orientation rashly has precipitated itself into an abyss of troubles, thereby forfeiting the prosperous pastures of the mechanistic engineering approach of strictly encapsulated black boxes. In particular, the symptoms of this unwholesome precipitation become manifest in *the fragile class problem,* which on closer analysis falls apart into a family of more or less related fragility problems, which was systematised into a small taxonomy above. We saw that there are two main branches of the fragility problem, the *syntactic* and the *semantic* one, and surveyed a variety of earlier attempts to expel each of these, none of which turned out to be quite satisfactory. Finally, I suggested *dynamic linking and compiling with caching* as a remedy for the *syntactic* problem and *encapsulated inheritance* as an antidote against the *semantic* problem, maintaining that both of these schemes will be reasonably easy to take advantage of and will provide reasonable solutions to the problems at hand. If this will actually prove to be the case, component-orientation and object-orientation will indeed have been reconciled and unified into a somewhat new-fangled programming style, for which I proposed the designation *encapsulated programming,* thereby wishing to emphasise the fundamental rôle played by the concept of *encapsulation* in this scheme. Although the adoption of this programming paradigm will certainly not imply a general across-the-board rejection of *objects* as we currently know them, it will indeed entail the surcease of the use of such objects in the rôle of *components*. As a compensation, it should nonetheless bring the dire consequences of the Gadarene jump of object-orientation to naught, giving birth to the new, promising race of *capsules,* i.e. truly well-encapsulated *component objects,* undefiled by the fragility problems that corrupted their object-oriented predecessors, but must be eschewed in order to bring McIlroy's and Cox' vision of software componentry to life.

[1292] Object-oriented programming was originally devised for simulation purposes, and within the domain of simulation the *world metaphor* obviously makes sense also at the programming level. The generalisation of object-orientation into an all-purpose programming paradigm, which is to say that the *world metaphor* is applied universally to all kinds of programming, is a much more problematic step for reasons that should be clear by now.

1.3 WORLDS IN A GRAIN OF SAND

Although there has been a tremendous interest in *graphical user interface (GUI)* technology for the last two decades and huge amounts of effort, money, and time have been spent on research and product development within this realm, little *really* significant progress has been seen in real-world user interfaces beyond the desktop-based *GUI* established by the epochal breakthroughs at *Xerox PARC* in the 70s and early 80s. Taking today's state-of-the-art object-based user interfaces as a starting-point, we will consider a few different developments that appear to go beyond the desktop metaphor, or even beyond personal computing at large. Amongst these, special attention will be paid to 3-D user interface technology and, in particular, to its non-immersive variety, also occasionally referred to as 'desktop virtual reality'. In keeping with the agenda of realistic computing outlined at the outset of the present chapter, I will argue that a 3-D user interface based on business objects as envisioned by Oliver Sims constitutes a promising, although in some respects still somewhat inchoate approach towards a better user interface than today's flat desktop *GUI*. Finally, I will venture some brief musings on how I believe a 3-D business objects-based user interface to a personal computer should appear to the users and how it could be implemented on top of a software component technology, such as *Microsoft's COM*.

In the much-cited memo *Through the Looking Glass*, John Walker, the founder of the *CAD* software company *Autodesk,* takes exception to the common habit of organising the history of computers into four generations, which correspond to the underlying fabrication technologies: vacuum tubes, transistors, SSI/MSI integrated circuits, and LSI/VLSI chips.[1293] Instead, he suggests the mode of user interaction as a more interesting principle of systematisation and accordingly discerns five generations of computers:

1) Plugboards, dedicated setup
2) Punched card batch, RJE (Remote Job Entry)
3) Teletype timesharing
4) Menu systems
5) Graphical controls, windows

Indeed, Walker's reorganisation of computer history seems to be vindicated by the fact that the *user interface (UI)* constitutes such a quintessential component of most present-day computing systems; to most users the user interface *is* the computer, whereas its inner structure and workings will be of rather limited interest. In particular, this will be the case with reference to the users of *personal computers (PCs)* and *workstations,* which today unexceptionally interact with their users through a *graphical user interface (GUI).* Although current user interface technology and its historical gestation will be given some attention in the present study, our primary concern here will be similar to that of Walker's memo, to wit the future mode of user interaction and the future user interface of personal computers, or rather a particular image of what this future interface will be like. The general thrust of our study will be determined by the surmise that the personal computer is about to moult from its current modus operandi as a tool for running applications into a 3-D *virtual world* or *virtual environment.* We will in due time attempt to undergird this belief by various arguments, but the reader should be aware that there is no consensus as to whether or when this transformation will happen, what market and other forces might propel it, or even if it is at all probable and desirable. In the last chapter of this thesis, I will come back to the question of its desirability at some length. Neither is there any consensus on the future rôle of the *personal computer,* but in contrast to some proponents of alternative computing paradigms, I believe the *personal computer* will retain its importance for the foreseeable future, even though it is likely to metamorphose in various ways and, in particular, become much more easily transportable as a result of the decrease of its form factor.

For the purpose of the present study, it will be useful to distinguish three distinct aspects or "levels" of user interface technology, viz. the *device,* the *system,* and the *art and application level.*[1294] The *device level* comprises the hardware *I/O (input/output)* devices, such as keyboard, mouse, and *VDU (Visual Display Unit),* whereas the

[1293] [Walk88b]

[1294] This division was devised by some researchers at Fujitsu for the realm of artificial reality. See [Rhei91] p. 306 et seq.

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art and application level is about the more or less artistic design of the visible user interface for different objectives and application areas. From the point of view of the user, the *system level* is considerably less manifest, occupying the nebulous abode betwixt and between the hardware and the visible user interface, with both of which the user directly interacts. Thus, at the *system level* resides the software that acts as the glue and the enabling technology for the other levels, determines the general appearance of the user interface, and sets the overriding rules and boundaries for what can be done in user interface design. Although admittedly the three levels are closely intertwined and can only be strictly separated *in intellectu,* the focus in this essay will be on the system level, which is to say that we intend to dilate neither upon different hardware devices, nor on what constitutes good or bad interface design.

Graphical user interfaces, virtual worlds, object-orientation as well as a variety of other developments of computing have a common starting point in the *world metaphor,* i.e. the conception of the computer, its user interface, or a computer programme as a small world of entities, often referred to as "objects". From the point of vantage of this metaphor, it appears that making the objects of the computer-based "world" correspond to real-world entities in order to minimise the *semantic gap* between model and reality would conduce to qualities generally deemed desirable, such as intelligibility and learnability. This idea is the basis of the object-oriented approach, and objects having a real-world counterpart are often referred to as *business objects*.

The primary objective here is to investigate the possible relationship of the kind of *business objects* envisioned by Oliver Sims to an imagined future 3-D user interface of the computer, the two of which seem to dovetail remarkably. An important starting point for Sims' ideas was the *object-based user interface (OBUI)* of the *OS/2* operating system. In the chapter on business objects, I have already briefly discussed *object-based user interfaces*[1295] and also presented Sims' user interface ideas, which form the foundation of my own ideas about the synthesis of virtual worlds and *Newi*-style business objects presented below.[1296] In this chapter, I also looked into the common roots of the "object-oriented approach" and today's graphical, more or less "object-oriented" user interface technology.[1297] I will not repeat these discussions here, but refer the reader to these sections.

1.2.10 BUSINESS OBJECTS AND THE USER INTERFACE OF THE FUTURE

The original user interface of *Newi* was based on the *CUA-91 (Common User Access-91)* guidelines and the now somewhat dated *MDI (Multiple Document Interface) GUI* style, which makes a *frame window* encompass multiple *client windows*. Although the *GUI* was somewhat modernised in subsequent versions of *Newi,* the document-centric style, which became prevalent later and implies a much tighter integration of the screen objects, remained absent from the *Newi GUI*.[1298] Thus, as far as the user interface is concerned, the business objects of *Newi* led very sequestered lives, each being encapsulated in its own window. Although this seclusion may seem to go well with an *object-oriented* or *object-based* user interface, business objects would undoubtedly profit from the capability to participate in more integrated forms of presentation, such as *compound documents* or the *forms* used in *Visual Basic* and other *RAD* development environments. Such capabilities are increasingly supported by mainstream commercial software, and the lack hereof made *Newi's* entirely window-oriented user interface seem rather behind the times.[1299] In our view, a business object infrastructure should be built on top of a component technology, and, provided this technology offers the necessary support, as would be the case with *Microsoft's COM/OLE/ActiveX*, a component-based infrastructure should indeed make close visual integration, if not exactly easy, at least feasible.

Just like business objects, *compound documents* tend to break down the stark boundaries of the "traditional application". However, they do so not by blowing the monoliths up and transmuting their constituents into independent business objects, but by making monolith applications amalgamate visually so that they appear

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[1295] See above p. 128.

[1296] See above p. 144.

[1297] See above p. 124.

[1298] See [ES98] p. 289 et seqq. provides a minor modernisation of this *GUI*. On some early plans for support of *OpenDoc,* see [OHE96b] p. 329. Cf. also [SSA97b] p. 12 and [ES98] p. 287.

[1299] Cf. [OHE96b] p. 327 et seqq.

seamless, although they will still remain discrete applications, acting as very large-grained components that co-operate through the subtle schemes of co-ordination set down by *OLE* and similar technologies. These same schemes of interoperation may be used by components on the whole gamut of granularity. Consequently, very large-grained applications such as *Word* or *Excel* may interoperate with small- or middle-grained *ActiveX* controls. Furthermore, *compound documents* may be further generalised into a *document-centred user interface* as exemplified by the *Xerox Star.*[1300]

Whereas the *desktop metaphor, compound documents,* and the *document-centric interface* dovetail with document management and office automation systems – the main sphere of interest of *Xerox* –, they may be considerably less appropriate in other contexts and circumstances. As a matter of fact, if we believe that the computer should provide a malleable microcosm, capable of mirroring all aspects of life relevant to our computing needs and desires, the desktop metaphor seems grandiosely parochial in scope. A wealth of other metaphors has been tried in actual systems, but most of these are either but supplementary to the desktop metaphor or useful only within a certain, usually quite narrow, domain.[1301]

One innovative attempt to advance user interfaces beyond the omnipresent desktop was *Taligent's People, Places, and Things,* which attempted the implementation of a *task-centric* user interface. Three-dimensional user interfaces provide another line of development, largely fostered by the recent *VRML (Virtual Reality Modeling Language)* standard and its use for the creation of *virtual worlds* on the *World Wide Web*. Subsequent sections will be devoted to these two advances, but ere we pursue these topics, we will, however, have to cast some glances at alternative future user interfaces and computing paradigms.[1302]

2.1.1.17 Beyond the Desktop Metaphor

In a *Wired* interview some years ago, David Gelernter categorised the potential substitutes for the desktop metaphor proposed in the research literature into three groups, to wit *spatial, semantic,* and *networked,* of which

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1300 See p. 130.

1301 [Coll95] p. 195 et seqq. contains a catalogue of metaphors. Most of these actually fit into a document-centric interface quite well. In [Nels90], Ted Nelson castigates *metaphorics* and "the new *Metaphoric Ideology"* as misleading and restrictive and instead advocates "well-thought-out unifying ideas". Nelson also makes a plea for "the movie analogy" and more artistry in the design of user interfaces, and much in the same vein [Laur91] discusses theatre as an overriding metaphor for human-computer interaction. A similar line of argument can be found in [GN96], where a warning is issued that metaphors may "enshrine outmoded technology". Cf. also [HM82].

As pointed out by [Smit87], there is a tension between *literalism* and *magic* in user interface design. Whereas *literal* features preserve metaphors and enhance the intelligibility of the interface, *magic* ones certainly break metaphors, but allow us to take fuller advantage of the capabilities of the computer. Likewise, [Kay90] p. 199 suggests *user illusion* as a better term than *metaphor* and emphasises how various "magical" properties of these are made possible by the computer. Cf. also [Togn95] and [Coll95] p. 207 et seq.

[LJ80] takes the radical view that all human understanding is based on metaphors and that knowledge is structured in layers of metaphors, the most fundamental of which derive from basic physical experiences. Chapter 2 of [Trav96] analyses the metaphors underlying different programming styles, and [Coyn95a] p. 249 et seqq. provides an interesting discussion both of the use of metaphors in computing and design and of different philosophical interpretations of the *metaphor* concept.

1302 Of future studies concerned with the development of computing, many have a strong emphasis on societal and human consequences, but are weak on technology aspects. Amongst the technically more informed studies, there is a gliding scale from cautious predictions based on actually existing research prototypes – usually propped up by some guarded extrapolations – to unmitigated science fiction-style or "extropian" speculations, which, starting from controversial anthropological and philosophical premises, take fabulous and doubtful future breakthroughs in artificial intelligence, artificial life, nanotechnology, space travel, robotics, and various other domains and disciplines more or less for granted. An example of the more cautious line of argument is provided in the two books [Dert97] and [Dert01], where Michael Dertouzos, head of the laboratory for computer science at *MIT,* presents a well-informed vision of the future of computing, basing his views on insights in current research projects at *MIT* and elsewhere. Likewise, [DM97] and [Denn99] provide a miscellany of level-headed essays on the future of computing, as does http://www.almaden.ibm.com/almaden/npuc97/index.htm, the web site of the *New Paradigms for Using Computers* conference. Some popular computer magazines have featured the future theme in an interesting way, including the *Communications of the ACM* (February 1997 and March 2001), and *PC Magazine* (June 9, 1998 and June 22, 1999, September 3, 2002). Another journalistic survey of future computer technologies is provided by [CNET98]. See also [WM96], [Coch98], [Gers99], [Mora88], [Mora90], [MW92], [Stor97], [Kurz90], [Kurz99], [Kaku97], [Leeb91], [Leeb95], [Gray99], [Negr96], [Vedi97], and [Nels97a] for some further, more or less up-to-date, views on computers and the future. In addition, the web sites of the departments of computer science at a few leading-edge universities and research institutes, such as *MIT's Media Lab, Xerox PARC, Microsoft Research, IBM Research, Bell Laboratories, British Telecom, MCC, BBN,* and *Intel Architecture Labs (IAL),* provide valuable resources of information on many significant directions of research currently pursued and, thus, a helpful starting-point for speculations and extrapolations about the future of computing.

the *spatial* category will be the by far most popular one.[1303] A *spatial* organisation of information was suggested by Nicholas Negroponte and his co-workers already in the middle of the 70s[1304], and this notion has since been refined by techniques such as George Fumas' *fisheye views,* which conserve screen estate by diminishing distant objects[1305], or the rotatable *cone trees* of Stuart Card and his *Xerox PARC* associates[1306].

The *semantic* approach attempts to organise information by content rather than by location. This line of thought is exemplified by *Internet*-based search engines such as *Alta Vista* or by the *Semantic File System* proposed by an *MIT* research project as a replacement of the directory-based file system of *UNIX*. Recently, the notion of the "semantic web", promoted by Tim Berners-Lee and others, has gained some currency.[1307] The *networked* style is found in hypertext systems and web browsers and has its roots in the ideas of Vannevar Bush and Ted Nelson. Gelernter proposes a fourth approach, *Lifestreams,* which is based on a *chronological* principle of organisation, according to which all pieces of data pertaining to a particular person from the birth onwards are to be arranged in chronological order in a *lifestream.*[1308]

It can be argued that all the above new-fangled interface styles supplement rather than replace the *desktop metaphor*. In our opinion, the only one of them that has the potential of replacing – or perhaps rather generalising and metamorphosing – the *desktop metaphor,* is the spatial one. The desktop is by itself an example of a spatial metaphor, although set in a 2-D rather than a 3-D space, and the implementations of the semantic, networked, and chronological metaphors all likewise need to be *situated* in some kind of *space* that can be displayed on a computer screen.[1309] Thus, we hold that the spatial metaphor will remain the fundament of desktop-style computing and will integrate and embrace the other proposed metaphors. As far as the semantic and networked metaphors are concerned, this has actually already largely been accomplished – or at least made possible – through the tight integration of the *Internet Explorer* browser technology with the *Windows* operating system and user interface. However, a more radical shift from today's *personal computing* style will also be possible, as we will now see.

2.1.1.18 Beyond Personal Computing

The 'alternative' user interface metaphors discussed in the previous section all rest on the supposition that we in the future will interact with the computer in basically the same way as we do today, i.e. through a screen, a keyboard, and a mouse, possibly supplemented by various pieces of multimedia and other equipment. If we try to unmoor our conception of the computing style of the future from the shackles of today's man-machine interface and its associated paraphernalia, we may, however, envision some more radically different modes of interacting with the computer.

One path leading beyond the realms of personal computing is that of immersive *virtual reality,* which implies that the user dons some kind of special equipment, such as a head-mounted display (HMD) and a data glove or a bodysuit, that will create a sense of immersion within a computer-generated three-dimensional 'world'; *artificial reality* offers a variant hereof, where the user does not wear any special gear, but the 3-D

1303 [Stei97]. Cf. also [Dam97] and [Dam98].

1304 See, for example, [Negr77] p. 700 and [PKL97] p. 50 et seq.

1305 See [Furn81] and [Furn86a].

1306 See [RMC91a-b].

1307 See [Dert01] p. 71 et seqq., [BHL01], and [BH01]. Cf. also http://www.w3.org/2001/sw and http://www.semanticweb.org.

1308 *Lifestreams* are described in [FF95], [FG96], [CFFG96], and [FFG96]. Cf. also [Bolt79] p. 44 et seq. for a related style of presentation. By the bye, [BG97] p. 5 presents some calculations on the storage needed to record all information processed by an individual during his lifetime and also speculates on when such storage capacities will become feasible. (The numbers arrived at are: Read text: 60-300 GB, speech as text: 15GB, speech as compressed audio: 1.2 TB, compressed video: 1PB.) Cf. also [Lesk97] for an estimate of the total amount of information in the world, among other things.

1309 A recent addition to the list of candidate substitutes for the desktop metaphor is provided by Ted Nelson's prototype *ZigZag* system, which may be viewed as an attempt to unify the *networked* style with a multidimensional variant of the *spatial* style, called the *Quantum Hyperspace* by Nelson. See [Nels98] for further particulars.

'world' is created through video projections and the like.[1310] We will come back to this topic in the section on three-dimensional user interfaces below.

Misgivings about the virtuousness of the path of *virtual reality* have been put forward by, for example, the proponents of *ubiquitous computing* (at times referred to also as *pervasive computing, calm computing,* or *invisible computing),* another major attempt at a radical break with today's habits of computing. In a much-cited article, the late *Xerox PARC* researcher Mark Weiser, the originator of this agenda, inveighed against the goal of disembodied immersion entertained by virtual reality adherents as "diametrically opposed" to his own vision of *ubiquitous computing* or *embodied virtuality,* which instead aims at such a seamless integration of computers into everyday life that the computer devices, rather than the human bodies, will "vanish into the background".[1311] According to this vision, computers of very different physical sizes – from very small *tabs,* over paper-sized *pads,* to blackboard-sized *boards* – connected through either conventional cables or wireless radio and infrared links, will in the future become truly ubiquitous. Hundreds of such devices may be present in one room in addition to a galore of embedded computers concealed in all kinds of equipment and artefacts, which in this way will become – more or less – "smart". Furthermore, people will wear "active badges" that make it possible to track their positions, at least so it is suggested. Such positional information can be used to direct telephone calls to the telephone set momentarily closest to a person, or to have any computer workstation, at which a user chooses to sit down, start up with this particular user's own customised desktop. Instead of arranging information into overlapping windows on a single CRT display, *pads* may be used as mobile, detachable windows that may be arranged more freely and comfortably and without overlap on top of a physical desk. *Tabs* may serve as smart notepads or pieces of paper and *boards* as intelligent, multifunctional whiteboards and shared workspaces, capable of displaying slide shows, all kinds of multimedia, video/TV, etc.

A wealth of research efforts are currently devoted to the development of "things that think"[1312], i.e. smart devices, smart houses, smart rooms, smart desks, smart chairs, smart clothes, smart cars, smart toys, smart dust,[1313] in short smart everything – even smart matter, the properties of which will be changed through the use of intricate systems of embedded sensors, actuators, and computers. Also I/O technology is developing rapidly. *Tab*-like, pen-based notepad computers of different sizes and styles have been mass-produced for some time now, and *pads* intended as substitutes for books are beginning to appear on the market as well. Pen-like computers supporting the scanning of printed text are also available at affordable prices[1314], and the next logical step are pen computers capable of recognising hand-written text and translating it into a stream of characters.[1315] Additionally, high-resolution, wall-sized displays are now about to become comparatively common; the need for them was stated already by Licklider in 1960.[1316] Research attempting to make paper a dynamic, reversible output medium by coating it with programmable "microencapsulated cells" is also underway.[1317]

To these hors-d'œuvres on the table of the brave new world of computer ubiquity, may be added – among other by today's standards outlandish things – *BodyNets* of implanted and wearable computers that will

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[1310] See [Krue91] and [Krue93].

[1311] [Weis91]. Cf. also [Weis93], [WB97], [Sull98a-b], and [KCR91], a plea for "distributed, augmented reality" in contrast to "enclosed, simulated reality". In a similar vein, [Norm98] advocates *information appliances* as an alternative to *personal computing.* Interestingly, Weiser largely drew the inspiration for his approach from Heidegger's technosceptical philosophy, which all since McLuhan's prophetic pronouncement that "Heidegger surf-boards along on the electronic wave as triumphantly as Descartes rode the mechanical wave" (in [McLu62] p. 248) has wielded a paradoxical and ever-increasing influence on the field of computing. See [Sull99]. Cf. also [WF87] p. 27 et seqq., [Heim93] p. 55 et seqq., and [Coyn95a] p. 5 et seqq. et passim. At http://www.webcom.com/paf/techlinks.html, various papers on Heidegger and technology are listed. A special issue (11:4, 1998) of *Information Technology & People* was devoted to Heidegger and computing; see http://www.emerald-library.com/cgi-bin/EMRtoc.cgi?level=6&keyno=5949&pnum=2&keyno2=42&keyno3=5949&jno=161.

[1312] See [Gers99] and http://ttt.media.mit.edu.

[1313] [Wyli99]

[1314] Details about the *C Pen* from *C Technologies/Anoto Group* can be found at http://www.anotogroup.com.

[1315] *British Telecom's SmartQuill* was claimed to do this. See http://www.innovate.bt.com/aboutus/ourheritage?doc=41010.

[1316] See [Silv98] and [Lick60]. Cf. also http://www.ti.com/dlp.

[1317] See http://www.media.mit.edu/molecular. [Metz98] quotes the *MIT* researcher J. Jacobsen as estimating the time-to-market for *electronic ink* as less than two years from then. See also [Turk98] and [Dam97], which survey various input technology developments (cf. footnote 1424 on p. 281 below).

render their users regular *cyborgs*.[1318] The implanted variety may serve prosthetic or health supervisory purposes or may be used to control equipment in the outer world[1319], whereas the wearable devices are supposed to act as "guardian angels", i.e. personal assistants that record, index, and retrieve what we read, hear, and see in order to augment our memory and supply various useful services. A few years ago, a research project at *BBN* constructed *BodyLAN,* a radio network capable of connecting a hundred nodes distributed over the human body[1320], and similar *Personal Area Networks* have been developed by groups at *MIT*[1321], *IBM*[1322], and elsewhere. In addition, research prototypes of *wearable computers* serving as *remembrance agents* or navigational aids have been devised.[1323] *Wearable computers* have been in production and available for purchase for some time, but the market for these devices is still small due to the novelty of the product category, high prices, and the clumsiness of some of the equipment used, although these impediments can be expected to be eliminated before long.[1324] These appliances are closely related to *augmented reality* systems, by which term is understood systems that blend the virtual and the real by overlaying our perception of reality with computer-generated images.[1325] To achieve this, special equipment is needed, such as the *head-up displays* used in some aeroplanes and automobile windscreens or special goggles[1326] that may allow wearable computers to display, for example, e-mail, mnemonic notifications, and other information on the surface of the glass.

Considering the simmering activity in this field currently, the influence and power of some of its supporters, and its economical potential, the success of *ubiquitous computing* and all kinds of smart *information appliances* seems almost ineluctable. In contrast to some proponents of this and other would-be alternative computing paradigms, such as net-centric/web-centric computing or virtual reality, we, however, hold that the *personal computer/Dynabook* also is a thing with a resplendent future. Although the personal computer will doubtless undergo major transformations and, in particular, its form factor will eventually shrink into pocket-size and smaller, whereupon the resulting *pocket PC* will be combined with a wide range of I/O devices as fit for the user's current whereabouts, the core idea of *one* strictly *personal,* general-purpose computing tool will, I believe, survive and flourish. *Stationary* I/O equipment (such as traditional keyboards, mice, and screens, of which, however, most will be flat and some wall-sized or paper-like) will be preferred, when we need to use the computer for extended periods of time, *wearable* (e.g. spectacled output and microphone input), when we are strolling around, and *notepad-style,* when we attend meetings or go by aeroplane, train, or bus. This personal device will also continue to be our preferred oriel window onto the web and enterprise, home, or body networks and the vehicle, through which we will access the pervasive smart equipment of the future. In addition, some kind of graphical user interface will most likely remain the venue where man and the personal computer meet also in the future. Indubitably, this *GUI* will evolve and metamorphose in various ways, and we will now present the lineaments of some developments that in our view plausibly forebode the character of the evolutions and revolutions to come.

[1318] See [BG97].

[1319] See http://www.kevinwarwick.com, [Sanc98], [Witt99], and [Mitc99].

[1320] See http://www.bbn.com/getsmart/sdp/tpo.htm and http://www.bbn.com/products/mobile.htm.

[1321] See http://www.media.mit.edu/physics/projects/pan/pan.html.

[1322] See http://www.research.ibm.com/topics/popups/smart/mobile/html/pan.html.

[1323] [Rhod97] provides a historical survey of this field. See also http://www.media.mit.edu/wearables and http://wearcomp.org for more details about *wearable computers.* Interestingly, Ted Nelson started the idea of wearable computers already in the 60s/70s, although it is generally held that the researchers called the "eudaemons" built the first operable wearable computer in the mid-70s, a shoe-based device intended for roulette-prediction purposes. Around 1980, Steve Mann created a wearable computer, which more closely foreshadows the current breed of wearable machines. See [Nels98], [Nels73] p. M26, and [Mann97a-b].

[1324] [McKa98c] gives some details of a prototype *Wearable PC* from *IBM Japan,* whereas [Brow98] describes the *Xybernaut 133P,* and [Spiw99] reviews its successor, the *Xybernaut Mobile Assistant IV,* which is currently in production. See also http://www.xybernaut.com, http://www.ibm.com/products/gallery/wearablepc.shtml, and http://www.jp.ibm.com/esbu/E/wpc/index.html.

[1325] [Rhei91] p. 96 et seq. describes an early example of an augmented reality system, built by Ken Knowlton at *Bell Labs.* In order to create configurable *virtual keyboards,* Knowlton used half-silvered mirrors to superimpose an image on a keyboard, to which blank keys had been fitted. Half-silvered mirrors are also used in some more recent *augmented reality* hardware.

[1326] *MicroOptical Corporation* works on such *Eyeglass Display Systems.* See http://www.microopticalcorp.com.

1.2.11 *PEOPLE, PLACES, AND THINGS* AND THE TASK-CENTRIC USER INTERFACE

For a number of years, an ambitious attempt to create a "pure" object-oriented operating, programming, and user environment was worked on by *Taligent,* a consortium founded in 1992 by *IBM* and *Apple* – in 1994 *Hewlett-Packard* joined in as well by acquiring a 15% share. The company was finally closed down in January 1998 after a period as an *IBM* subsidiary, and the engineers not laid off were transferred to *IBM.* During its years of operation, *Taligent* developed *CommonPoint,* a portable object-oriented *application system* consisting of a large number of *C++* frameworks (more than 100 frameworks, about 2000 classes and 27,000 methods[1327]!), and the neoteric user interface of *CommonPoint,* fittingly named *People, Places, and Things.*[1328]

People, Places, and Things was an attempt to advance and generalise the *document-centric GUI* with its bias towards clerical office work into a *task-centric GUI* believed to be more appropriate for "knowledge workers", who will be wont to frequently shift *tasks* and to collaborate extensively with each other.[1329] In a *task-centric* interface, the user's computer needs are organised into different *tasks,* which connect *people* and *things* through the concept of *places,* i.e. collaborative environments, each customised for a certain *task* through a unique organisation of its interface objects.[1330] Hence, *People, Places, and Things* does not support just a single place, the desktop, as traditional *GUIs* do, but multiple places, which have different interface objects and *rule* sets defined for them and may simultaneously lodge any number of users, who interact through shared digital workspaces, such as electronic whiteboards or shared documents.

For instance, every user may define an office *place,* which other users may visit electronically in order to get in contact with him, to hand over a document, or to leave a message, in case he is not in at the moment. Other places may represent electronic meeting rooms, shops, theatres, etc. Some places may allow only a single user, others a restricted number of visitors, and others still any number of people. A user may define new places for new tasks, and he may survey these places and navigate between them through visual *maps.* Other users can be granted access to a place through a *postcard,* which corresponds to the place.

People are represented indirectly either by their *business cards,* which also hold various pieces of information about them, or by photo-style icons, which indicate direct interactive presence at a place. Additionally, people may be aggregated in metaphorical containers such as phone books, mailing lists, organisation charts, etc. *Things,* finally, fall into a number of categories:

[1327] So [OHE96b] p. 300. [Szyp98a] p. 13, citing an *Ovum* report, states the number of methods as 53000!

[1328] [CP95] accounts for the *Taligent* project from different points of views, whereas [Tal94] expounds *Taligent's* guidelines for *C++* programming and [Tal95] provides technical details about the framework philosophy of the company. A concise account of the *Taligent* endeavour can be found in [OHE96b] p. 297 et seqq., and some additional bits of information are given in [Pote], [SHK93], [Sant95], and [Myer95]. See also http://hpsalo.cern.ch. *Taligent* was a merger of *Apple's Pink* project, which aimed at the development of a next-generation object-oriented operating system, and the *Patriot Partners* effort of *IBM* and *Metaphor* – the latter company, which was acquired by *IBM* in 1991, had been founded in 1982 by David Liddle, late of *Xerox PARC,* and some other *Xerox* defectors in order to generalise the ideas of the *Xerox Star* into a workstation for decision support. The name *Taligent* was likewise a merger – of "talent" and "intelligent". *CommonPoint* was released for *AIX* in early 1995 and for *OS/2* somewhat later, but was a commercial fiasco. Only parts of the *People, Places, and Things* interface described here were actually implemented in the released products. Of late years, *Taligent* has developed the *WebRunner Toolkit,* which comprises a number of tools for building *JavaBeans* and *servlets* as well as assorted *JavaBeans. Taligent* technology has also been integrated into *IBM's VisualAge* product line.

[1329] [CP95] p. 75 et seqq.

[1330] [Kay90] p. 200 mentions a related concept, "project views", which was implemented by Dan Ingalls already in *Smalltalk-76* and provided support for multiple "places", each with its own set-up of tools and materials and its own state that was restored whenever it was entered. [HC86] gives a thorough account of a *Xerox* research system called *Rooms,* which provided sophisticated support for such *virtual workspaces.* In *Rooms,* it is possible to jump between workspaces through *Doors* or pop-up menus, to return to the previous room through a *Back Door,* or to survey all rooms in an *Overview* picture as well as their door connections in a *Wiring Diagram.* Various advanced techniques are provided for, e.g. the sharing of windows between different rooms, the inclusion of a room into other rooms, the moving or copying of a set of windows as *Baggage* when shifting from one room to another, and the putting of a set of windows in a user's *Pockets* so as to escort him on his virtual vagrancy. In other systems, doors are sometimes referred to as *wormholes, teleports,* or *portals.* Several commercial and freeware utility programmes have popularised the concept in more or less elegant ways.

- *desktop elements,* such as documents, folders, trash cans, disk drives, windows, menus, stationery pads[1331], etc.
- *appliances,* such as printers, scanners, fax machines, telephones, cameras, etc.
- *cursor tools,* i.e. general[1332] or application-specific tools, such as selection, pencil, eraser, and text tools, approval stamps, spell checkers, translators, etc.
- *business objects* – or *business things* – such as forms, reports, sticky notes, invoices, routing slips, ballots, machines, books, magazines, movies, calendars, money, credit cards, business cards[1333], etc.[1334]

Additionally, *CommonPoint* and *People, Places, and Things* supported various kinds of state-of-the-art technology, including the integration of all kinds of multimedia and other devices, the routing of information through *workflows,* extensive groupware capabilities, and the management of compound documents containing different types of data.

Clearly, in environments like *People, Places, and Things* business objects[1335] modelling real world entities make good sense. Although *Taligent* was a commercial miscarriage, mainstream *GUIs* have rapidly moved in the direction foreshadowed by *People, Places, and Things.* Actually, various seemingly futuristic ideas and features present in *People, Places, and Things,* such as conferencing capabilities, whiteboards, and *business cards,* have now found their way into widely used *GUIs,* such as *Windows 98/NT,* although it remains to be seen if its overriding *task-centric* approach, and in particular the *place* metaphor, will do likewise.

Apparently, there has been some flux of ideas from the demesne of *virtual reality* into the design of *People, Places, and Things.* This interesting area, which began to attract wide attention in the late 80s and the early 90s, will provide the topic for the next section.

1.2.12 THREE-DIMENSIONAL USER INTERFACES

The notion of a 3-D user interface is closely associated with the idea of *virtual reality (VR),* i.e. a computer-generated 3-D "micro-world", where users stroll about and interact with 3-D objects and, possibly, other virtual rovers as well. There are two main types of *virtual reality* systems, usually referred to as *immersive* and *desktop VR.* Whereas the former provide users with a sense of *immersion* into a 3-D world through the use of special equipment, such as head-mounted displays and data gloves, the latter do not attempt to create an immersive experience at all. Instead, a projection of a 3-D world is made on the screen of an ordinary computer monitor, which, as it were, will appear to the user as a window into this world. Hence, *desktop virtual reality* is sometimes also referred to as *Window on a World (WoW)* technology.

1.2.13 IMMERSIVE VIRTUAL REALITY

The term *virtual reality,* or *VR* for short, was coined in the mid-80s by Jaron Lanier, a leading champion of the field and the founder of the company *VPL Research,* which during its years in operation contributed greatly to the popularisation of immersive *VR* technology by producing various *VR* software and gear, such as the

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[1331] *Stationery pads* are used by the operator to create new objects and documents in *People, Places, and Things* and are needed in order to purify the user interface from application icons. Together with *programmable containers* and *embeddable components,* they are categorised as "extensions of desktop elements" in contrast to the "familiar desktop elements", such as documents, folders, disk drives, etc. *Programmable containers* may be used as "smart folders" to do things like gathering links to all documents of a certain type or to all files older than a certain date. *Embeddable components* are desktop elements that may be embedded inside a compound document.

[1332] In *People, Places, and Things,* global tools are preferred whenever possible. Cursor tools are parts of *palettes,* also known as toolboxes.

[1333] Just as in the real world, *business cards* are not by themselves *people,* but *things* that represent and contain various pieces of information about *people.*

[1334] In most cases, these *business objects* could be embedded inside another object of almost any kind, linked to other objects (also across a network), and shared with other users.

[1335] "Business objects" are here understood in the usual general sense, not in the restricted *Taligent* sense just stated above.

famous *DataGlove, EyePhone,* and *DataSuit.*[1336] As a concept, *virtual reality* looks like an oxymoron and is by no means uncontroversial.[1337] "Artificial reality", "synthetic reality", "virtual environments", "synthetic environments", "virtual worlds", and "cyberspace" are some other household words that may be encountered in the literature, although the purviews of these different concepts are not exactly the same. Notably, the term *artificial reality,* which was coined by Myron Krueger in the mid-70s, is often made to refer to a distinct variety of *virtual reality,* where the "user" needs no special VR equipment (thus also the expression "wireless VR"), but enters straight into an "artificial reality" or "responsive environment" created through video projections inside some kind of *stationary* (or *spatially) immersive display (SID),* such as a *cave* or *media room.*[1338]

Aside from in "virtual reality", the epithet "virtual" is used rather widely in today's technical computing terminology. Tellingly, the fourth edition of the popular *Microsoft Press Computer Dictionary* provides no less than 39 entries that start with "virtual".[1339] For one thing, the terms "virtual memory" and "virtual machine" have been widely used since the 60s.[1340] Notably, Ted Nelson, in an article published in *Creative Computing* in 1980, used the term *virtuality* to designate the illusion created by an interactive system (or movie), its "conceptual structure" and "feel", as opposed to the underlying "reality", which, according to Nelson, consists of data structures, programming languages, and the like.[1341] Jaron Lanier might, however, have had another source of inspiration for his coinage besides computer jargon, to wit the French drama theoretician Antonin Artaud, who put forward his influential ideas about theatre as a "réalité virtuelle" in *Le Théâtre et son Double* already in the 30s.[1342]

As a philosophical concept, the term "virtual" goes back to the heyday of medieval scholasticism. In particular, it played a central part in the philosophy of John Duns Scotus, who used it to characterise the relation between an object or entity *(ens)* and its empirical attributes *(passiones entis),* which were said to be contained by the object *virtualiter* (in effect).[1343] The term is occasionally used also by later theologians and philosophers, such as Peirce, who defined virtuality thus: "A virtual X (where X is a common noun) is something, not an X, which has the efficiency *(virtus)* of an X."[1344] By this reckoning, the sun could be said to be *virtualiter* on earth and Milton to have pored over whether angels had virtual or immediate touch. More recently, the French philosopher Pierre Lévy has made virtuality the central concept of his own social philosophy of the age of networked computing.[1345]

1336 See [Rhein91] p. 154 et seqq. and [Fole87]. *VPL* was acquired by *Sun* in 1998 and is no longer operative. Jaron Lanier is also well known for his ideas about "post-symbolic communication", a postulated future mode of communication. By means of very rapid programming in a visual language, of which Lanier has made various prototypes, a user is supposed to create a VR representation of the ideas he wishes to communicate, which may then be directly inspected by another user. In this way, a more direct form of communication of ideas and concepts than is possible through the mediation of language, speech, and printed text would, according to Lanier, result. Cf. also [Lévy91].

1337 For example, [Walk88b] argues that both *virtual reality* and *artificial reality* are oxymorons. Cf. also [Heim93] p. 123.

1338 See [Krue83], [Krue91], and [Krue93]. A well-known science fiction variant of such an artificial reality is the *Holodeck* room of the *Star Trek: The Next Generation* TV series.

1339 [Micr99g]. Cf. also [Wool93] p. 58 et seqq.

1340 For an assortment of references to early articles that treat of these concepts, see [Denn70] and [PG74].

1341 [Nels80]

1342 So [Eber97] and [Davi98] p. 190.

1343 See [Heim93] p. 132 and [FW95] p. 120 et seqq. and p. 156 et seqq. The term *distinctio virtualis,* used in scholastic theology and philosophy as a synonym of *distinctio rationis ratiocinatae (quae habet fundamentum in re),* i.e. a distinction by reasoned reason (that has a foundation in reality), signifies a distinction between things that are not really distinct, as two separately existing things – distinguished through a real distinction or *distinctio realis* – are, but only distinguished by the analytical reasoning of the human mind. Nonetheless, this distinction has a foundation in reality, in contrast to the *distinctio rationis ratiocinantis,* the distinction by reasoning reason, which is purely imaginary. In particular, the *distinctio virtualis* is used with reference to the attributes or perfections of God. See [Mull85] p. 49 and p. 93 et seq. Cf. also [Rune62] p. 83 and p. 112.

1344 See [Espo97] lecture 4.

1345 See [Lévy98]. Following Deleuze, Lévy, in an ambitious attempt to create "a cartography of the virtual", argues that the *virtual* is not to be opposed to the *real,* which would imply that it would be something imaginary and false. Rather, *the real* and *the possible* (or *potential)* form a pair of opposition, where *the possible* is to be understood as an exact picture of *the real,* "static and already constituted", differing from *the real* only by its lack of existence. *The virtual* is not so clearly defined, but is "a kind of problematic complex, the knot of tendencies or forces that accompanies a situation, event, object, or entity, and which invokes a process of resolution: actualization". Consequently, *the*

2.1.1.19 *Virtual* Reality Equipment

Virtual reality systems come in many different flavours, but the immersive varieties are all dependent upon specialised, more or less costly and exotic input/output equipment, in addition to a powerful computer graphics system, which acts as an *image generator (IG).*[1346] The output devices can be classified by the sense organ affected into visual (sight), auditory (hearing), tactile (touch), and kinaesthetic (balance/position detection) appliances.[1347] In actual equipment, tactile and kinaesthetic feedback are often intermixed; such mixed devices are called "haptic", whereby their relevance for grasping and gripping actions is implied. Olfactory (smell) or gustatory (taste) equipment is not in widespread use. Commonly employed VR output devices include:

- *Head-mounted displays (HMDs)* present a stereoscopic or, less commonly, monoscopic view to the user through two small display units (typically *LCD* displays) mounted in a helmet- or goggle-like device.[1348] *HMDs* are very differently priced; the display *resolution* and *field of view (FOV)* are two important factors, which influence pricing. A head tracker and (3-D) audio device may be integrated with the *HMD*. There are also variants of 3-D displays that are not intended to be donned: One, at times called a "fop", is supposed to be held as a pair of opera glasses, whereas a *BOOM (Binocular Omni Orientation Monitor)* consists of a binocular display box attached to a two-section arm, so that it can be moved in any direction by the user.
- Different kinds of *stereoscopic binoculars,* which are used with a conventional monitor or a TV set*,* offer a cheaper and less clumsy alternative to *HMDs*. For example, *LCD shutter glasses* can enhance the gaming experience of some graphical computer games through the illusion of depth.
- *3-D audio devices* or *sound convolvers* co-ordinate the various properties of sounds with the position and movements of the user.
- *Tactile* and *force feedback* devices, also known as *haptic* devices, give feedback to some part of the human body (fingers, hand, arm, wrist, chest, skin, etc.). Force feedback may be effected through a joystick or the like, or, less commonly, through mechanically linked "exoskeletal" devices, which are wrapped around the hand or some other limb, or through some kind of arm-like device, such as the *Argonne Remote Manipulator (ARM),* that can be manoeuvred by the user. Fingertip actuators may bring tactile feedback to a data glove,

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virtual is to be contrasted to *the actual;* its relation to *the actual* can be likened to and illustrated by the relation of the seed to the tree. Although the seed certainly prefigures the tree, it does not predetermine it fully, but the tree is *actualised* through a process, where the determinants inherent in the seed interact with environmental and other factors and forces. Lévy also contrasts the process of *actualisation,* through which the tree dynamically finds it form, thereby solving the problem indicated by the seed, to the reverse process of *virtualisation,* whereby a solution is transformed into a problem-complex. The latter process, exemplified by the virtualisation of a company, "fluidizes existing distinctions, augments the degrees of freedom involved, and hollows out a compelling vacuum". Lévy regards virtualisation as "one of the principal vectors in the creation of reality" and discerns its outcroppings in language, which is to be understood as "the virtualization of the immediate present", technology, which is interpreted as "the virtualization of physical action", and contract, which is said to virtualise violence.

1346 The literature on virtual reality is rather large, although its pace of growth seems to have slowed down somewhat since the early 90s. Additionally, the borderline between *virtual reality* and the more general concept of *cyberspace* is fuzzy and the two concepts are often confounded. [Rhei91] and [PT93] provide classic, although somewhat dated, introductions to virtual reality technology. [Isda98] is a very concise, but more up-to-date web-based introduction to the field. Other surveys are provided by [AB92b], [Hami93], [Wool93], [CO93], [Stev94], [DM95], [Bric97], [SZ99], [Ande99], and [Hill99]. Some collections of papers and essays include [Bene91], [TT93], [Wexe93], [BL95], and [Mark96a]. At http://www.hitl.washington.edu/projects/knowledge_base, a valuable bibliographic database of the field compiled by Toni Emerson of the Seattle-based *Human Interface Technology Lab (HITL)* is available, although since the spring of 1999 it is, unfortunately, no longer updated. On Swedish VR research, see [Nils00].

1347 [AB92b], [PT93], and [BD95] provide excellent and profusely illustrated surveys of VR I/O devices, whereas [DM95] contains detailed research surveys of the VR equipment available for each of the human senses. Various pieces of commercial VR hardware and software are listed at http://www.tekgear.com and http://www.vrealities.com.

1348 In a stereoscopic display, each eye is fed with a picture, the viewpoint of which differs from that of the other eye by the distance between the eyes (approximately 6.5 cm).

thereby, for example, making it possible to simulate the feel of a virtual key click. Devices for temperature display, "virtual sandpaper", etc. have also been built.[1349]

In addition to the above fairly standard pieces of VR equipment, there are also various more specialised, exotic, expensive, or experimental output devices:

- *Autostereoscopic displays* present a "volumetric" 3-D image to users without requiring them to don special headgear or goggles.[1350] There are various approaches to bringing about autostereoscopy, including the use of lenticular screens, sophisticated optical apparatus, and holographic techniques.[1351]
- *Virtual Retinal Display (VRD)* is a technology developed at the *Human Interface Technology Lab* in Seattle, using *laser scanning* to create 3-D images directly on the retina of the human eye.[1352]
- *Virtual model displays (VMDs)* are small workspaces or *work surfaces,* on which a 3-D model is displayed, much in the same manner as an ordinary table may host a model railway. Occasionally it will be possible to tilt the work surface at different angles as well.[1353]
- Cubic *caves* (sometimes also referred to as *portals),* wide-screen hemispheric *VR theatres,* or planetaria-like *digital dome theatres* can be used to create panoramic, video-projected "artificial realities". In simulators, entertainment establishments, and the like, such *stationary* (or *spatially) immersive displays (SIDs)* can be used for what is occasionally referred to as "armchair VR".[1354]

There are also a number of commonly used VR input devices:

- The *data glove* is, together with the *HMD,* the essential constituent of the popular conception of an immersive virtual reality system. The data glove is usually put to use through some kind of gesture recognition. For instance, it may be possible for the user to "fly" in a certain direction in 3-D space by pointing with the glove. The glove may also provide tactile feedback through fingertip tactile actuators.
- *6DOF* (six-degrees-of-freedom) *mice* and *wands* as well as various other devices, such as *force balls* or *space balls,* can be used in lieu of a data glove in order to facilitate navigation in a 3-D space.
- *Position trackers* (such as the famous 'Polhemus') are used to keep track of the motions of the user so as to synchronise the graphics and sounds presented to him with his present location in virtual space.
- *Video cameras* can be used for various purposes, including *gesture-recognition* (so typically in an *SID* environment) and *telepresence,* which enables a user to make observations at another site. If special devices are taken advantage of, such as infrared cameras or X-ray apparatus, the user can be transformed into a *supersensory human being*[1355], capable of seeing in the dark or of observing the viscera of a human body.

Additionally, there are some categories of not so common input equipment:

[1349] Cf. [Rhein91] p. 312 et seqq.

[1350] See [Hall97] and [Börn97]. Cf. also [Rhein91] p. 248 et seqq.

[1351] At http://www.3dmedia.com, the web site of *Dimensional Media Associates,* the *High Definition Volumetric Display (HDVD)* technology, which is based on the use of precision optical components, is described. [Luce97] describes some holographic and [Börn99] some lenticular developments.

[1352] See [PFV98] and [VPNF98].

[1353] [MB97b]

[1354] See [Lant97]. Cf. also [Jaco93b], where the term "location-based VR" is used for *BattleTech's* flight simulator-like gaming "pods".

[1355] [Dert97] p. 70

- *Gaze trackers* are used to record the eye movements, e.g. for navigational purposes or to enhance picture resolution in the direction the user gazes.
- *Bodysuits,* such as the legendary *VPL DataSuit,* can be used for various purposes, including the recording of human motion schemes, which then may be used in animations. A *bodysuit* can also be used as an output device to give different kinds of tactile or force feedback.
- *Treadmills* and *stationary bicycles* or *cars* may be utilised to facilitate walkthroughs inside a virtual building or drives in a virtual landscape.

Immersive virtual reality systems may be utilised for a wide range of functions, although these generally tend to be rather specialised. Important application areas include simulation and training (e.g. flight simulators, military battle simulation, training of surgeons, educational microworlds), architectural and other design (e.g. virtual walkthroughs of buildings or rooms under design), scientific, medical, or other visualisation and modelling (e.g. of aerodynamic, chemical, astronomical, economic, etc. models), entertainment (e.g. gaming, exercising, virtual interactive theatres, 3-D movies), and the facilitation of *telepresence* in dangerous or otherwise inaccessible environments (e.g. remote control of robots in nuclear plants, spacecraft, or semiautonomous weapon systems).

1.2.14 THE HISTORY OF VIRTUAL REALITY – SOME HIGHLIGHTS

As the inchoation of the area of virtual reality, Ivan Sutherland's short and speculative, but extremely influential *IFIP* paper *The Ultimate Display* is often cited.[1356] Here Sutherland characterises the computer display as a "looking glass into a mathematical wonderland" and suggests that it may help us gain familiarity with phenomena that we cannot easily experience with our senses, such as the forces of charged particles, or to explore concepts that have heretofore never been visualised. The enigmatic title of the paper is explained in its last paragraph, where Sutherland indulges in a brief, but striking flight of cybernetic fancy: [1357]

> *The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked.*

In the same paper, he also considers non-visual output mechanisms, such as audio and force feedback (through a joystick) as well as various kinds of input devices including typewriters, light pens, tablets, and eye trackers. In 1966 at Harvard, Sutherland and his disciple Robert Sproull came up with the idea to feed computer-generated images into a head-mounted display, originally intended to be connected to an infrared camera in order to enable a helicopter pilot to land in the dead of night.[1358] They called this device "the sword of Damocles", since it had to be suspended from the ceiling because of its heavy weight.

Sutherland's ideas did of course not crystallise out of thin air: Flight simulators, theatre, movies, and science fiction literature provided various exemplars and precursors foreshadowing what was to come, as did age-old religious and philosophical speculations and strivings. Some technical milestones on the road to virtual reality were Link's mechanical flight simulators, widely used during World War II, Fred Waller's *Cinerama* wide-screen cinema invented in the 50s and used in around a hundred theatres until the early 60s, and Morton Heilig's *Sensorama,* a one-spectator version and proof of concept of Heilig's vision of a multi-sensory "experience theatre" devised a little later than the *Cinerama.*[1359] In literature, something akin to virtual reality was de-

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[1356] [Suth65].

[1357] Cf. [Dam97] p. 64 where the ultimate goal is understood as minimising the *cognitive distance* between intent and its execution: "The ideal interface is no interface–"I think, therefore the computer gives me what I thought about (and what I should think about)". A more feasible goal to strive for is the computer as perfect butler, à la Jeeves, who knows my context, tastes, and idiosyncrasies and discreetly does my bidding by anticipating my needs without needing explicit direction."

[1358] See [Rhei91] p. 104 et seqq. and [Suth70] p. 70 et seq.

[1359] See [PT93] p. 19 et seqq., [Rhei91] p. 49 et seqq. and p. 203, and [Wool93] p. 40 et seqq.

scribed as early as in 1909 by E. M. Forster in *The Machine Stops,* where men are imagined to be living in a gloomy world of underground cubicles, entertained and cared for by machines.[1360] Some other famous landmarks in VR fantasy will be Aldous Huxley's concept of *feelies* (a kind of multi-sensory, immersive cinema) in the famous dystopian novel *Brave New World* written in 1932 and *Ray Bradbury's* description of various interactive, immersive *VR* rooms and machines in *The Veldt, The Happiness Machine,* and *Fahrenheit 451,* all composed during the 50s.

Some time after Sutherland's and Sproull's seminal *HMD* experiments, Thomas Furness, working for the U.S. air force on display technology and flight simulators from 1966 to the late 80s, developed together with his group of co-workers some very sophisticated *HMD* technologies, including the famous *VCASS (Visually Coupled Airborne Systems Simulator)* "Darth Vader Helmet" and its successor *Super Cockpit.*[1361] In 1989, Furness became the founding director of the Seattle-based *Human Interface Technology Lab (HITL),* now one of the leading centres for research on virtual reality, where, for example, the development of the promising laser scanner retinal display technology is going on.[1362]

Frederick Brooks, the manager for the development of *IBM's OS/360* system during the mid-60s and the author of *The Mythical Man-Month*[1363]*,* the classic study of the tribulations of software development, was also one of these *VR* pioneers caught by Sutherland's visions in *The Ultimate Display.*[1364] Since the late 60s, he has been heading a group at the *University of North Carolina,* which has made numerous important contributions to virtual reality as a research discipline and built many "virtual world systems", including several intended for scientific modelling, e.g. of molecules and human viscera, as well as the renowned *WALKTHROUGH* system for simulated promenades inside virtual buildings. As a consequence, the *University of North Carolina* is now widely regarded as a Mecca of virtual reality research. Other pioneering work was made by Myron Krueger, whose "artificial reality" approach and experiments with video projection techniques resulted in various systems with suggestive names, such as *GLOWFLOW, METAPLAY, PSYCHIC SPACE,* or *VIDEOPLACE,* primarily intended for artistic purposes.[1365] An important constellation during the 70s was Nicholas Negroponte's *Architecture Machine (Arch Mac) Group* at *MIT,* which became the nursery of many later stars and champions of the field. In 1980, the *Arch Mac Group* was transformed into the celebrated *MIT Media Lab,* to which we will soon come back.[1366]

For short, subsequent spells during the 80s, the *Atari Research* laboratory in Sunnyvale and the *Human Factors Research Division* of *NASA/Ames* in Mountain View became important focal points of virtual reality research and development. The endeavour embarked upon at the latter site, aiming at the teleoperation of robots in spacecraft, was instrumental in the development of comparatively low-cost VR equipment, including *HMDs* made from standard components, the 3-D audio *Convolvotron* technology, and the data glove, invented in 1980 by Thomas Zimmerman of *VPL.*[1367] As a result, virtual reality equipment started to be produced by a small cottage industry of VR companies such as *VPL.* In 1988, *Autodesk* launched its *Cyberia* project, thereby setting out on a long journey in the realms of virtual reality and 3-D technology. For one thing, the leading 3-D modelling tool today, *3D Studio Max,* is developed by the *Autodesk* subsidiary *Kinetix.*

1360 [Fors1909]. [Jaco93a] is an anthology of VR-related short stories, also including a brief bibliography of VR novels. Cf. also [Poru96], section 14 of [Isda98], and many of the papers in [MW92]. The influence of science fiction literature on leading edge research on computers and computing is briefly touched upon in [Bran87] p. 224, [Rhei91] p. 139 et seq., [AB92b] p. 12 et seq., and [Pesc99b]. Cf. also [Walk88b], where John Walker admits that Frederick Pohl's *Beyond the Blue Event Horizon* provided the inspiration for *Autodesk,* and [Heim93] p. 121, where Gibson's *cyberspace* and the VR room known as the *Holodeck* in the TV series *Star Trek: The Next Generation* are identified as two fundamental "threads of shared vision" in the VR and cyberspace research community. Another science fiction novel, which has wielded some influence on *VR* researchers, will be Vernor Vinge's *True Names.*

1361 See [Furn86b], [FD86], and [Furn88].

1362 See [Rhei91] p. 193 et seqq., [PT93] p. 39 et seq., and the *HITL* web site http://www.hitl.washington.edu.

1363 [Broo95]

1364 See [Broo77], [Broo88], and [Rhei91] p. 36 et seqq.

1365 See [Krue83], [Krue91], [Krue93], and [Rhei91] p. 113 et seqq.

1366 See below p. 274.

1367 See [Rhei91] p. 131 et seqq. As pointed out in [Krue91] p. 71 et seq., there are at least two designs of data gloves predating that of Zimmerman.

In the late 80s and early 90s, a period of great expectations and heady speculations of a breakthrough for immersive virtual reality technology followed, and many new research initiatives were initiated all over the world.[1368] Arguably, the zenith of this excitement was reached at the *ACM SIGGRAPH* conferences in 1989 and 1990; the latter event was even declared "one of the most important meetings ever held by human beings" by the ageing LSD prophet and VR aficionado Timothy Leary.[1369] Hitherto these expectations have hardly been met, and although *virtual reality* often figures prominently in the attempts to descry the future of technology and computing perpetrated by futurologists, computer pundits, science fiction writers and others, it has also attracted its own retinue of detractors and doubters, amongst the advocates of alternative future technologies as well as amongst the technosceptics at times sweepingly and somewhat derogatorily referred to as "neo-Luddites".[1370]

1.2.15 THE CRITIQUE OF VIRTUAL REALITY

The issues and criticisms raised concerning virtual reality technology in general and its immersive variety in particular are both wide-ranging and quite heterogeneous in character.[1371] The strictures passed by the advocates of *ubiquitous computing* have already been touched upon, primarily playing up the would-be usability problems of a 3-D user interface.[1372] Some usability issues, mainly pertaining to 3-D navigation, will be discussed below, and possible remedies will also be considered there.[1373] Furthermore, various health dangers implicit in the use of immersive virtual reality equipment have been pointed out, including both physiological disorders, such as eyestrain, nausea and headache,[1374] and psychological ones, such as the *Alternate World Syndrome (AWS)* described by Heim and its chronic variant *Alternate World Disorder (AWD),* which both make "images and expectations from an alternate world upset the current world, increasing the likelihood of human errors".[1375]

In our view, 3-D technology is still in a too early stage of development – presenting, for instance, many basic unresolved technical problems – for the controversy on the usability of 3-D user interfaces, be they immersive or non-immersive, to be settled in something even faintly reminiscent of a conclusive way. Obviously, the issues at hand can only be satisfactorily addressed by the actual construction and close evaluation of real-world 3-D systems, carefully designed so as to remove, mollify, or steer clear of any serious usability problems encountered. Until the fundamental technical problems of VR have been adequately addressed, extensive reality tests have been carried out, and a fair period of evolutionary refinement has been allowed for, the usability-related expostulations against 3-D user interfaces will be redolent of the attitude previously articulated in, for example, doubts as to whether man would be able to cope with the high speeds of railway or automobile transportation or in the remonstrance against graphical user interfaces frequently heard some years ago from those accustomed to a character-based one. Arguably, man has evinced a tremendous capability for adaptation to new devices and questionable user interfaces throughout history, and it seems that the perceived desirability and usefulness of a new tool often defeat any concerns about poor usability. Clearly, the dispute on usability also reflects a deeper clash in philosophical outlook between different understandings of what the computer, cosmos, and man essentially is or ought to be – as well as the combatants' vested interests in competing agendas and visions of the future of computing.

[1368] A huge number of research groups and projects are listed at http://www.hitl.washington.edu/kb/research.html.

[1369] [Wool93] p. 12 et seqq. See also [Barl89], [CLMF+89], and [JBBD+90].

[1370] The *Luddites* were British workers, who for fear of unemployment demolished textile machines during a number of riots in 1811-1816. They were named after a certain Ned Ludd, who is reported to have destroyed weaving machinery in 1779. See [Sale96] and [Mazl93] p. 68 et seqq.

[1371] [Heim98] p. 33 et seqq. discusses the "cyberspace backlash" and surveys the rapidly growing technocritical literature, which, however, mostly is concerned with media, computerisation, virtualisation, and cyberspace in general rather than with virtual reality technology in particular. Cf. also [Mark96a] and [Ågre98a-b].

[1372] See p. 263 above.

[1373] See the section on *Three-Dimensionality in the Crucible* that starts on p. 280 below.

[1374] See [WM97].

[1375] [Heim98] p. 210. See also id. op. p. 173 et seqq.

As is the case with many other technologies, there are uses of *virtual reality* that are intrinsically controversial from an ethical point of view, such as the telepresent control of weapons through a *VR* interface, to say nothing of the imagined usefulness of *VR* technology for propaganda, mind control, and brainwashing in *Brave New World*-like scenarios.[1376] At a more fundamental level, virtual reality seems to bring out sharply many of the deep issues of modern life and culture and, in particular, of our ever-increasing intoxication with media of different kinds. If today's media, such as the boxed-up flatlands of non-immersive, non-interactive television (or of non-immersive, but interactive computer gaming), are capable of spellbinding the masses and of propagating, undermining, and homogenising beliefs, morals, and attitudes in ways that many of us will find disquieting or unpalatable, their immersive VR counterparts have the potential of becoming immensely more impressive, powerful, and addictive; hence also the talk about virtual reality as "electronic LSD".[1377] If people start spending large portions of their spare time (and perhaps working time as well) in synthetic worlds, the contents of which may be as diverse as those of any medium, thereby taking part in, as it were, an exodus from reality as well as the much less intrusive alternative realities provided by literature, theatre, art, and the like, this will indubitably have consequences for mankind and society that will give at least some of us pause. For all their significance, we will have to postpone our consideration of these matters to the next chapter, since a reasonable treatment of them needs to be founded on extensive investigations and considerations of a philosophical and theological nature.[1378]

1.2.16 NON-IMMERSIVE VIRTUAL REALITY

In a survey article published in *Computer* in 1993, the well-known *Xerox PARC*-based user interface researchers Robertson, Card, and Mackinlay pointed out a number of problems that haunt immersive VR technology including:[1379]

- a non-evolutionary technology adoption path
- potential resistance among office users – and many others as well – to donning clumsy VR equipment that will isolate them from their physical environment
- various technical problems pertaining to immersive displays, including low display resolutions, time lags in input devices, display jitter, and difficulties of stereo synchronisation

A more humble approach, variously referred to as *desktop virtual reality* or *nonimmersive virtual reality,* dispenses with the fancy equipment and instead attempts to visually convey the impression of a virtual world through the screen of an ordinary workstation, possibly supplemented by some low-cost output devices, such as loudspeakers for sound or a joystick for force-feedback. There are also various middle courses between immersive and desktop VR, such as *fishtank VR*[1380]*,* where the user, having donned a head tracker and a pair of shutter glasses, interacts with the computer through the screen and the keyboard. Hereinafter we will be pri-

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[1376] See [Rhei91] p. 387 et seqq., [Krue91] p. 263 et seq., and [Ster93].

[1377] See [Rhei91] p. 353 et seqq., [Zett96] p. 91 et seqq., and [Keow98].

[1378] *Philosophy of technology* is a discipline concerned with the evaluation of technology, among other things. A good introduction to this field is provided by [Mitc94]. There is a rapidly growing literature on the philosophical aspects of virtual reality and cyberspace. Authors, who have made noteworthy contributions to this genre, include Michael Heim (see [Heim93] and [Heim98]), Richard Coyne (see [Coyn94], [Coyn95a-b], [Coyn98], and [Coyn99]), Pierre Lévy (see [Lévy97] and [Lévy98]), and Philip Zhai (see [Zhai98]). Philosophically oriented or tinged bits and pieces are also to be found in some surveys of VR, such as [Wool93] and [Rhei91], and in many conference proceedings and collections of papers about VR and cyberspace, such as [Bene91], [MW92], [BB95a], [BL95], [Ess96], [Mark96a], [Hole98], [Wood98], and [Heud99a]. Philosophers frequently cited in this context include Plato, Leibniz, Heidegger, Baudrillard, Teilhard de Chardin, and, of course, McLuhan, if indeed he can be called a philosopher. Attempts to trace the philosophical and religious roots of virtual reality and cyberspace are found in [Heim93] p. 83 et seqq., [Keep93], [Davi98] p. 190 et seqq., [Poru96], [Hayl96], [Hill99], and [Hayl99]. Cf. also [Cohe66], [Bolt84a], and [BG99] p. 160 et seqq.

[1379] [RCM93a]. A more up-to-date list of problems can be found in [Broo99]. [Heud99b] p. 23 makes a distinction – analogous to those made for artificial intelligence and artificial life – between a strong and a weak claim about the realism of virtual worlds. Whereas the weak claim assumes that virtual worlds are but simulations or "symbol systems" and nothing more, the strong programme "holds that some of these virtual worlds could be as real as our physical world is." Probably, most supporters of *nonimmersive VR* will endorse the weak, rather than the strong claim.

[1380] This term tries to convey that the experience of the user will be akin to looking into a fish-tank, rather than to being immersed amongst the fish. Both *desktop VR* and *fishtank VR* will give a sense of *presence* instead of *immersion.* Cf. [Dert97] p. 70.

marily concerned with *desktop VR,* although this is mainly a pragmatic choice of ours. From the *VR* software developer's point of view, there does not need to be a wide gulf separating the different varieties of virtuality, at least if the hardware is properly isolated from the software application level, although the hardware needed – and its price tag – will be very different, as will indeed the user experience and the user interaction styles.

Already Sutherland's *Sketchpad* supported the notion of the display screen as a window or viewport into a much larger virtual 2-D world, and this notion was soon to be generalised into three dimensions by Johnson's *Sketchpad III.*[1381] This idea has since been popularised by innumerable *CAD (Computer-Aided Design)* and *CAE (Computer-Aided Engineering)* systems, computer games, simulators, modelling and visualisation applications, etc.[1382]

The ordinary graphical user interface of today is essentially flat, but provides some features that have been characterised as 2½-D, insofar as they support a notion of layers of 2-D surfaces.[1383] The most conspicuous example will be the good old desktop itself, on which windows may be stacked to any level of complexity. The place metaphor of *People, Places, and Things* – also known as the room or virtual workspace metaphor – multiplies such 2½-D desktops and makes it possible to switch between them, but does not promote the user interface *per se* into the third dimension. Would it be possible to replace the ordinary 2-D/2½-D desktop-like graphical user interface with a 3-D user interface? If so, what would the potential benefits and drawbacks be? And what would the implications and prospects for business objects be? Before considering these questions, we will survey a number of developments that may be viewed as steps towards a 3-D user interface.

1.2.17 THE QUEST FOR THREE-DIMENSIONAL USER INTERFACES

In the latter part of the 70s, a very influential exploratory multimedia environment called the *Spatial Data Management System (SDMS)* was put together by Nicholas Negroponte and his co-researchers in the *Architecture Machine (Arch Mac) Group* of *MIT.*[1384] *SDMS* let a user seated in an armchair inside a *Media Room* fly over a 2-D *Dataland* landscape displayed on a wall screen. This landscape could, for example, consist of a set of windows with data, a map of the Boston area, or a desktop holding a calculator, a calendar, and a telephone. Through a variety of equipment, such as joysticks or a touchpad, the user was able to navigate, pan, and zoom in and out on the screen. In the *Put That There* prototype, the user was enabled to control a cross-formed cursor and move things around on the screen simply by pointing in the air with his own arm, to which a Polhemus tracker had been affixed, and by uttering voice commands such as "put that … there", and in other experiments gaze tracking was used for similar purposes. The *Aspen Movie Map* was built from video filmed sequences stored on videodisks and let the user "drive" freely through the streets of the town of Aspen in Colorado.[1385] By pressing a "season knob", the user could change the season of the year. Some buildings could be entered and would then disclose their interiors to the visitor, whereas others had "microdocumentaries" or historical pictures attached to them – the latter could be activated by pressing a "history knob".

[1381] See [Suth63a-b] and [John63].

[1382] Some inklings of the early history of *CAD* are given in [BGBS95] p. 38 et seq. According to [HMGR+89] p. 21 et seq., some *CAD*-like work on antennas was done at the *Whirlwind* by a certain Dom Combelec already around 1950. Although a simple graphical game was also played at the *Whirlwind* already in 1949, the first graphical computer game is usually said to be *Spacewar,* which was developed at *MIT* in 1961-62. [Levy94] p. 50 et seqq. provides a detailed account of its development. A very slightly modified version of the original *Spacewar*, running inside a *Java* applet emulating a *PDP-1*, is available at http://agents.www.media.mit.edu/groups/el/projects/spacewar. Video games such as *DOOM, Myst,* and *Riven* are among the graphically most sophisticated applications at hand presently. [Herz97] provides an attempt at a history of video games, and [Kadr97] gives some interesting background information about the meticulous labour needed to create sophisticated graphical games. See also [Shne98] p. 193 et seqq. Id. op. p. 528 et seqq. gives some examples of 3-D information visualisations. Cf. also [RCM93a-b].

[1383] [Glin87] and [Coll95] p. 201

[1384] See [Bolt79], [Bolt84b], [Hero80], [Bran87] p. 137 et seqq., [Negr96] p. 108 et seqq., and [Rhei91] p. 94 et seqq. The early work and thinking of the *Arch Mac* group, which was formed already in 1967, are surveyed and summarised in [Negr70] and [Negr75]. The *Arch Mac* group became the nucleus of the famous *Media Laboratory* of *MIT,* founded in 1980. The *Media Lab* was largely motivated by the desire to explore the consequences of the expected grand merger – foreseen by Negroponte already in the 70s – of the computer industry, the broadcast and motion picture industry, and the print and publishing industry. Cf. also [Gild89] p. 312 et seqq. and [Gild94] p. 53 et seqq., where the synthesis of the computer, the television set, and telecommunications through the arrival of the *telecomputer* or *teleputer* is predicted.

[1385] [Lipp80]. Cf. also [Niel95] p. 40 et seqq.

During the development of the *Lisa* computer, William Atkinson of *Apple* came to think of a demonstration of *Dataland* he had seen at *MIT* and was inspired to make a prototype for the *Lisa* of a *GUI* based on a very large zoomable virtual desktop, where the user could fly around, zoom, and click on icons representing documents. This *GUI* was soon rejected in favour of the now ubiquitous folder-based desktop, because remembering where documents were located on a huge virtual desktop was thought to put too much strain on users' memory.[1386] Although obviously Atkinson's prototype as well as the original *Dataland* interface were not true 3-D *GUIs,* their zooming and panning capabilities and large virtual workspaces pushed the 2-D metaphor towards the third dimension.

By adding perspective and some realism to the user interface, a first step towards a genuine 3-D *GUI* may be taken, as exemplified by the *Ark Workspace,* a piece of *GUI* software brought to the market in the early 90s. The elaborate 3-D user interface of this product, attempting to portray an office room realistically and accurately, was superimposed on a *Microsoft Windows* or an *Apple Macintosh* system as a kind of flashy 3-D façade.[1387] The *Ark Workspace* provided a detailed bitmapped representation of an office together with its diverse accoutrements such as a calculator, a calendar, a notepad, etc. Most of the picture was inert, but the parts of it depicting useful office equipment served as hot spots, on which the user could click in order to occasion some kind of behaviour. For example, if the user clicked on the calculator picture, the calculator of the underlying *GUI* system would be launched. However, it was not possible to move, remove, or add new items, nor was 3-D navigation supported, although clicking on some areas in the bitmap caused another bitmap to be displayed. The lack of easy customisability and navigation capabilities beyond bitmap hopping will make this kind of interface too static for sophisticated users, although computer neophytes may possibly be helped by its very explicit metaphors; at least this seems to be its very *raison d'être.*[1388]

For an extended period of time, a research group at *Xerox PARC* has been investigating how 3-D user interfaces could be utilised to good advantage, primarily for information visualisation purposes.[1389] In the beginning of the 90s, the efforts of these researchers focused on a system called *Information Visualizer*[1390], and more recently they have created two interrelated systems called *WebBook* and *Web Forager.*[1391] They argue that the successor of the desktop metaphor is likely to be shaped by the increasingly important needs of information access, rather than by the text processing needs that formed its predecessor. The metaphor of 2-D *rooms* or *virtual workspaces* – studied by this group in the 80s[1392] – has been generalised into a notion of 3-D *information workspaces* or *information landscapes,* suitable for tasks that typically will occupy *knowledge workers,* such as *information retrieval, sensemaking, design, decision making,* and *response tasks.* To support the use of such 3-D workspaces, the *Xerox* researchers have devised and explored a number of important techniques for 3-D display, 3-D navigation, and 3-D direct manipulation on ordinary desktop workstations.[1393] Of late, they have brought these

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1386 [PKL97] p. 50 et seq.

1387 At http://www.arkspace.com/prodsframe.html and http://www.arkspace.com/portframe.html a number of such 3-D bitmap interfaces used to be displayed, including *Planet Oasis,* a set of city scenes acting as a map to 450 web sites, and *The Apartment,* "a virtual home on the Internet", from which e-mail, a home page, various web sites, etc. may be accessed. [Coll95] p. 203 et seq. and [Stap93] discuss the original *Arc Workspace.* A few similar interfaces using a room, house, village, or city metaphor have been built by others, including *General Magic's Magic Cap* (see [CKS95]) and *Microsoft's* infamous *Bob.*

1388 [Stap93] suggests the use of perspective, light, and shadow as well as of transparency and opacity effects as a means to enhance an ordinary icon- and windows-based *GUI.* Such artifices can be used to create a desktop "landscape", where windows may be placed at different "distances" from the foreground, as indicated by their relative sizes and positions, and where some windows may be made semi-transparent, whereas others are given volume. [Ball94] describes a 3-D document handling system then under development and also draws an interesting parallel between the history of representational painting and the history of graphical user interfaces. He boldly concludes: "Overarching these is a movement from a codified, symbolic rendering of space, to realistic and hyper-realistic space, to the representation of conceptual space."

1389 Surveys of information visualisations are provided in [Fair93], [Youn96], [GEC98], and [Mors98], and [CMS99] brings together a lavish collection of papers on this popular topic. Cf. also [Niel95] p. 217 et seqq., [Schn96], and the interesting web site http://www.otal.umd.edu/Olive.

1390 See [CRM91], [RCM93b]

1391 [CRY96]. Cf. also [RCLR+98] for an account of *Data Mountain,* a 3-D replacement of the *Microsoft Internet Explorer 4.0* favourites facility.

1392 [HC86]

1393 Among the display styles invented are *cone trees* [RMC91a-b], *spiral calendars* [MRD94], *time lattices* [MRD94], and various *focus+context* techniques (i.e. techniques that allow zooming in on parts of a structure while still displaying the whole of it) such as *perspective walls*

techniques to bear on an innovative 3-D user interface to the web realised by the *WebBook* and *Web Forager* systems. The former is a book-like binder for web pages, allowing animated flipping of its pages[1394] as well as the "explosion" of itself into a mode of simultaneous display of its entire contents, where support for zooming is provided for through a *Document Lens*. *Web Forager* is a 3-D information workspace, consisting of a *Focus Place* for the currently studied web book or web page, an *Immediate Memory* 3-D landscape, in which books as well as individual web pages may be freely distributed, and a *Tertiary Place* bookcase, where web documents may be tucked away for future use. In addition to the spectacular possibilities of data visualisation, the combination of multiple workspaces with 3-D display techniques also provides some more prosaic, but nonetheless valuable advantages, such as expanded (virtual) screen space and increased on-screen density of information.

1.2.18 CYBERSPACE AND INTERNET-BASED VIRTUAL WORLDS

As evidenced by *WebBook* and *Web Forager* and prophesised by science fiction novelists and others for considerable time, virtual reality and *World Wide Web* technologies have now started to amalgamate. The idea of a global, virtual-reality-based *cyberspace,* the computer-generated "consensual hallucination experienced daily by billions of legitimate operators" was popularised by William Gibson in his renowned "cyberpunk" novel *Neuromancer*[1395] (published in 1984) and has since been promulgated by many works in this genre, such as Neal Stephenson's *Snow Crash*[1396] and other writings by Gibson, Stephenson, Sterling, Rucker, and others.[1397]

A somewhat similar vision, but with more direct links to on-going research and current technology, was put forward by David Gelernter in *Mirror Worlds,* a remarkable study predicting the appearance of software *mirror worlds* that will model projects, factories, companies, organisations, cities, etc.[1398] According to Gelernter, such *mirror worlds* will be *ensembles* of asynchronous, distributed *information machines* (or *infomachines* for short), interacting with each other through *Linda*-style *tuple spaces.*[1399] These *infomachines* are not, as one might expect, business objects representing real-world concepts, but rather traditional computer programmes, acting as highly specialised tuple processors and intended to be run in parallel, each in its own process on its own processor

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[MRC91a]/[RMC91b], *document* and *table lenses* [RC94], and *hyperbolic tree browsers* [LRP95]. *Point of Interest Logarithmic Flight* [MRC91b] is a navigation technique, and *Point of Interest Logarithmic Manipulation* and *fix and float* [Robe97] are direct manipulation techniques also devised by members of this group. Explanations and illustrations of many of these techniques are found in [RPHM+94] and [RCM93b].

1394 Page flipping was tested out already in the *Spatial Data Management System* of *MIT's Arch Lab*. See [Bolt79] p. 30 et seq.

1395 [Gibs84]. Similar ideas had been put forward earlier in this kind of literature, e.g. by John Brunner in *Shockwave Rider* and by *Vernor Vinge* in *True Names*. In Gibson's vision, users "jack in" their nervous systems directly to "the Matrix", the substructure of computers and high-speed communication networks making cyberspace possible. Cf. also [Poru96].

1396 [Step92]

1397 In [Walk88b], the memo (dated September 1988) that marked the start of *Autodesk's* important 3-D initiative, the founder of this company, John Walker, argued that *cyberspace* is a more appropriate term for immersive 3-D technology than *virtual reality* or *artificial reality*. Although Walker's appropriation of the term will have contributed considerably to its popularity, he used the term in a general sense, which did not imply the combination of 3-D technology and the *Internet*. Cf. [Rhei91] p. 174 et seqq. A series of conferences on cyberspace, the first one held at the University of Texas, Austin, in 1991 (see [Bene91]), also made for the popularisation of the concept. See http://www.cyberconf.org. [SJG96b] provides an excellent survey of the terminology (and literature) of cyberspace.

1398 [Gele91]. Cf. also [Gele89].

1399 Gelernter heads the *Linda* group at Yale and is the originator of *Linda,* a mechanism for asynchronous communication between parallel programmes. *Linda* allows a client to read (and possibly remove) *tuples* of data from a *tuple space* by means of pattern matching as well as to output data to the *tuple space* for other clients to read. *Tuples* are similar to the argument lists passed in procedure calls, but may hold any kind of data, including full *infomachines*. *Linda* uncouples readers and writers in both space and time: When a tuple is written to the *tuple space,* its intended reader needs to be neither currently active, nor known by a process identifier determining its physical location. It is perfectly possible to specify a name of a specific reader as one of the elements of the tuple, as well as to multicast a tuple to all *infomachines* that accept that particular kind of *tuple*. Since reading is done through pattern matching, it is, however, difficult and awkward to have a reader accept multiple kinds of tuples, which will have different number of arguments and different argument types. See [Gele91] p. 67 et seqq. and [BenA90] p. 110 et seqq. *JavaSpaces* (see [Sun99b]), which provides the foundation for *Sun's* much noted *Jini* technology, may popularise this style of interconnection and adds some features to it as well, such as support for time-limited *leases* and *Java's* rich and object-oriented typing system. Another way to bring about decoupling is to use a *software bus,* although this will only decouple producers and consumers in space, but not in time, since events, unlike tuples, are temporally transient. In contrast, *message queuing* decouples senders and receivers in both time and space (see below p. 590 et seqq.). Cf. also [BRMS+96] p. 71 et seqq. for a description of the related *blackboard pattern*.

in a multi-processor computer, or possibly in a cluster of single-processor computers that together form a *hypercomputer*. In addition, human operators may participate in an ensemble, which in this case is referred to as *Turingware,* in particular if *infomachines* and humans cannot easily be distinguished from each other. The *mirror worlds* built from such ensembles will have 3-D user interfaces and will appear as *deep* and *live pictures* of reality, which is to say that it will be possible to zoom between multiple levels of pictorial detail and that the information held inside them will be updated at real-time from a wealth of sensors and other input devices.[1400] *Mirror worlds* will also be *places,* and it will be possible for a user to rove such a place on the computer screen, chat with other rovers, and commission *agents* to find information and to do various other tasks on his behalf. Gelernter views *mirror worlds* as an expression of a deep-seated human urge to build microcosms, asserting itself in all kinds of artefacts such as paradise gardens, cathedrals, doll houses, model railroads, various works of arts, etc.[1401] The motivation for *mirror worlds* as well as other kinds of microcosms he optimistically identifies as a drive for *topsight,* a fundamental human impulse to observe, comprehend, and control the world.[1402]

The text-based multi-user chat systems and games usually referred to as *MUDs* may be regarded as a first uncouth crack at something vaguely reminiscent of Gelernter's *mirror worlds* and the cyberspace envisioned by dystopian *SF* novelists. The first text-based multi-user chat system appeared in 1978, and it was soon to be followed by others, some of which developed into multi-user rôle-playing games and world-building environments, popular mainly with a youthful public.[1403] Depending partly on their style, partly on other considerations, these text-based systems are referred to as *MUDs* (variously spelled out as *Multi-User Dungeons, Multi-User Dimensions,* or *Multi-User Domains), MOOs (MUDs Object Oriented), MUSHes,* and a plethora of other acronyms and designations.[1404]

The first graphical *MUD* was *Habitat,* created by Chip Morningstar and Randy Farmer at *LucasFilm* in 1985.[1405] *Habitat*, which ran on ordinary *Commodore 64* computers, contained most of the basic elements of today's *virtual worlds* – as graphical, navigable *MUDs* are now usually referred to –, although, of course, its simple 2-D graphics were very crude if measured by today's yardstick. In *Habitat,* as in current virtual worlds, each user was represented by an *avatar*[1406]*,* a visual stand-in. The *Habitat* avatars were able to chat with each other through typed-in text displayed in balloons at the top of the screen, and they could also gesture at each other, move around, pass between rooms through doorways, manipulate and use objects (through a joystick), and even shoot each other down. Each avatar had a personal on-line home and could participate in a variety of social activities and games. *Fujitsu* later acquired the *Habitat* system from *LucasFilm,* and its *Habitat II* and *WorldsAway* are still operative virtual worlds descending directly from *Habitat*.

The explosion-like growth of the *Internet* that followed upon Tim Berners-Lee's invention of the *World Wide Web* browser in 1990 and the ensuing development of graphical web browsers, starting with *NCSA*

[1400] [Gele91] p. 28 et seqq. The huge amounts of data that will billow through a *mirror world* are supposed to be handled and distilled step by step in multilevel *trellises* of tightly coupled *infomachines*. See [Gele91] p. 107 et seqq.

[1401] [Gele91] p. 181 et seqq.

[1402] One man's utopia will be the dystopia of someone else, as witnessed by the bomb sent to Gelernter by the infamous misotechnical mathematician Theodor Kaczinsky, also known as the *UNA* bomber. Gelernter was severely injured, but survived and later returned to his work as a professor at Yale.

[1403] [Powe97] p. 20 et seqq. The first system of that kind, *MUD1,* was built by Roy Trubshaw and Richard Bartle at the University of Essex. Also about the time this happened, the *Usenet* conference system began to come into widespread use. The ways and mores of the communities formed around the text-based multi-user systems have been studied by the psychologist Sherry Turkle in her two books [Turk85] and [Turk97]. Cf. also [Dame98] p. 519 et seqq. and [Mitc95a].

[1404] According to [Powe97] p. 11 and p. 21, *MUDs* mostly allow killing of other virtual inhabitants and are typically oriented towards adventure game playing, whereas *MUSHes* usually do not support killing and instead tend to encourage social skills. *MOOs* are object-oriented in the sense that they are built from *objects* and allow users to add new objects – things and places – through the use of some kind of script language. *MOOs* tend to focus upon peaceful *digital homesteading* and *world-building* rather than violent adventure gaming. [Powe97] p. 21 uses the term *adventure MUD* to signify any *MUD* allowing killing and *social MUD* for any *MUD* oriented towards object building and conversation. *IRC (Internet Relay Chat)* is an *Internet*-based facility for chatting only. Some *MUDs* have developed into *virtual communities* where people meet on a regular basis, typically in groups discussing a certain topic – the *LambdaMOO* of *Xerox PARC,* the *MediaMOO* of *MIT's Media Lab,* and *The WELL (Whole Earth 'Lectronic Link)* are some famous examples of such virtual communities. See [Rhei93].

[1405] See [MF91]. Cf. also [Dame98] p. 522 et seq. and [Powe97] p. 23 et seqq.

[1406] The term *avatar* denotes an incarnation of a god in Hindoo religion. *Habitat* pioneered the usage of this term for the user's virtual stand-in.

Mosaic in 1993, all at once fundamentally changed the general perception of what computing is all about, as well as the focus of the entire computer business. The idea to create a 3-D interface to the rapidly growing *WWW*-based cyberspace now began to look ripe for implementation and begot *VRML (Virtual Reality Modeling Language),* a language intended for the definition of 3-D objects and the combination of these into scenes and small worlds to be viewed and entered through a *VRML* capable web browser or web browser plug-in.[1407] *VRML 1.0* was established as a kind of industry standard in 1994, which was succeeded by a 2.0 version in 1996; somewhat later *VRML 2.0* was endorsed by *ISO* as the *VRML-97* standard. Currently, work is proceeding under the auspices of a task group of the *Web3D Consortium* to define an *XML*-based replacement of *VRML* known as *X3D (Extensible 3D).*[1408]

In contrast to some other significant 3-D technologies and standards, such as *Silicon Graphics' OpenGL* or *Microsoft's DirectX, VRML* specifies a file format and not an *API,* although the *VRML* browser will most probably take advantage of such an *API* when rendering the contents of a *VRML* file on the screen. A *VRML* file consists of *nodes,* which define different aspects of the objects and scenes of a *VRML* world. A user may stroll through a *VRML* world, navigating with the mouse, the keyboard, or, perhaps, a joystick. He may move in any direction he wishes, and as he moves, the viewpoint will change simultaneously. Objects inside a world may move by themselves and may interact with each other or with the user through events. Behaviour is specified through *script* nodes and is activated by events.[1409] Animations, movies, sounds, and *anchors* containing *URL* links to other *VRML* worlds or ordinary *HTML* web pages are also supported. Presently, a number of task and working groups of the *Web3D Consortium* is pursuing work in order to improve on the current capabilities of the *VRML* standard in various ways.[1410]

[1407] *VRML* browsers, *VRML* web browser plug-ins, *VRML* parsers, and *VRML* authoring tools abound. Many of these may be accessed from *The VRML Repository* found at http://www.web3d.org/vrml/vrml.htm. A somewhat dated evaluation of a number of *VRML97* browsers can be found at http://vrml.miningco.com/library/weekly/aa070698.htm. [CB97] and [HW96] are good handbooks on the *VRML 2.0* language; a plethora of advanced *VRML* topics are covered in [RCRR+97] and [Dieh01]. In addition, the *VRML* inventor Mark Pesce's books [Pesc95a] and [Pesc96a] are of some historical interest. *VRML/Web3D* conferences have been held yearly since 1996, and the proceedings of these (published by the *ACM)* contain much relevant material, some of which is or was available also at the conference web sites listed at http://www.web3d.org/fs_symposia.htm.

[1408] [Pesc97a], [VRML97a-b], [CCP97], and [HW96] p. 4 et seqq. provide accounts of the history of *VRML* or parts of it. The emergence of the *World Wide Web* inspired Mark Pesce and Anthony Parisi to embark on the construction of a virtual reality interface to the *Internet*. This was intended to encompass a 3-D web tool called *Labyrinth,* a *Cyberspace Protocol* for mapping spatial descriptors to host addresses, and a *Virtual Reality Markup Language (VRML)* intended as a 3-D counterpart or extension to the *Hypertext Markup Language (HTML),* and by February, 1994 a working prototype of *Labyrinth* had come into existence. Pesce was invited by Tim Berners-Lee to the first annual *World Wide Web* conference in Geneva in May 1994, and here Pesce, Parisi, and Peter Kennard contributed a paper, [PKP94], which was very favourably received at a *birds-of-a-feather* session. Encouraged by this, Pesce and Brian Behlendorf of the *Wired* magazine set up a mailing list in order to elicit proposals for a web-oriented 3-D modelling language. A number of submissions were received, of which the one submitted by *Silicon Graphics* garnered widest support in the mailing list community. Hence, this submission was presented as *VRML 1.0* at the second *World Wide Web* conference in October 1994. The proposal was based on a subset of the *ASCII File Format* of the 3-D graphics toolkit *Open Inventor,* extended with network support by Rikk Carey and Gavin Bell of *SGI*. During this process, the meaning of the acronym *VRML* was changed into *Virtual Reality Modeling Language,* as it was recognised that *VRML* was indeed not a mark-up language at all. In early 1995, *VRML* web browsers began to arrive, such as the *WebSpace Navigator* from *Silicon Graphics,* and somewhat later *VRML* authoring tools like *WebSpace Author,* likewise from *Silicon Graphics,* appeared on the horizon.

In August 1995, the *VRML Architecture Group (VAG)* was formed by a small number of *VRML* experts – including Pesce, Parisi, Bell, and Carey – in order to foster the development of *VRML* technology. This group soon issued an *RFP* for a second version of *VRML*. Once again, a *Silicon Graphics* submission, *Moving Worlds,* was preferred by the *VRML* mailing list community – other notable submissions were *ActiveVRML* from *Microsoft* (see [Elli96] and [Elli97]), *Out of This World* from *Apple,* and *HoloWeb* from *Sun*. Having established *Moving Worlds* as *VRML 2.0,* the *VAG* dissolved itself in late 1996 and invested the newly constituted *VRML Consortium* with the task of administering the further development of the technology. In 1997, *ISO* ratified *VRML 2.0* as an *ISO* standard called *VRML97* – reportedly, the first standard ever that needed less than 18 months to become adopted. In 1999, the *VRML Consortium* changed its name to the *Web3D Consortium* and initiated the work on *X3D*.

[1409] Somewhat peculiarly, the language to be used for the specification of behaviour is not ordained by *VRML*, but depends upon the browser. Among languages supported by popular browsers are *Java, JavaScript,* and *VBScript*.

[1410] See http://www.web3d.org/fs_workinggroups.htm. The most important of these groups will be the *X3D (Extensible 3D)* task group, which works on a proposal for an *XML*-based successor to *VRML*. The *X3D* syntax, which will be couched as *XML* tags, is entirely different from *VRML-97,* although backward compatibility will be provided for by a special *VRML-97* "profile". Another prominent feature of *X3D* will be "componentisation". An extensible, lightweight *X3D* "core" will supply basic 3-D capabilities, whereas more advanced functionality is supposed to be packaged as add-on components referred to as *extensions* and *profiles,* which are to be downloaded on demand over the web. *VRML-97* support may be delivered through such a profile component, and many of the proposals from the

The web revolution suddenly brought *MUDs* to the fore and made their prospects seem substantially more auspicious than when they lurked in the limbo of obscure bulletin boards and university networks. Web-based, graphical *MUDs,* usually referred to as *virtual worlds,* soon started to spring up like mushrooms. The first widely accessible 3-D *virtual world* was *Worlds Chat Space Station,* a non-*VRML* world that appeared in early 1995[1411], and it was soon to be followed by other 3-D worlds, many of which are *VRML*-based.[1412]

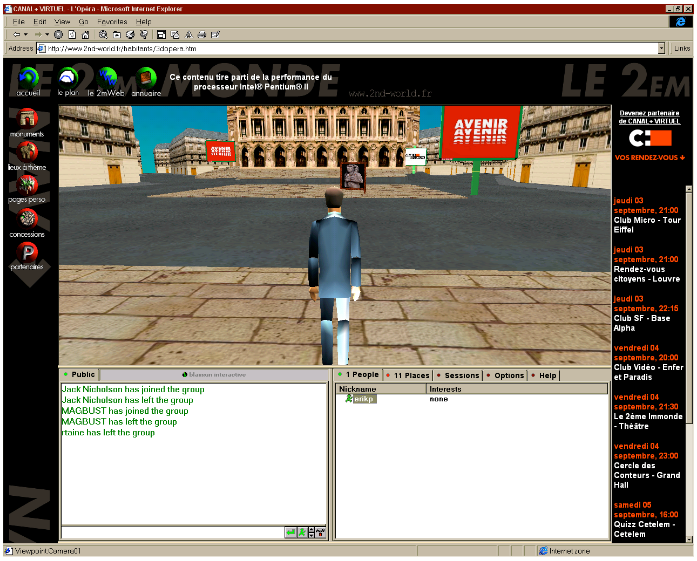

Figure 22. The author's avatar at the virtual Opéra of Paris (http://www.2nd-world.fr/habitants/3dopera.htm)

In most *virtual worlds,* each user is represented by his *avatar,* a visual 3-D stand-in, which may be more or less realistic or grotesque in appearance. The avatar may attempt to picture the traits of its owner[1413], but commonly it is just chosen from a library of "standard" avatars or put together from a number of pre-fabricated body parts.[1414] Avatars may communicate through text typed in by their owners or in some worlds

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Web3D working groups will presumably be implemented as extension components. See [Web399a-c], [Web302a-b], and the *X3D* web site http://www.web3d.org/x3d.html.

Besides the *X3D* task group, there are groups working on improvements in the existing *VRML* scripting facilities, on the integration with other technologies such as *Java/Java 3-D* and *MPEG,* and on an *External Authoring Interface (EAI),* which provides a facility – already supported by many *VRML* browsers – for interaction between a *Java* applet and a *VRML* world. Other task groups have addressed performance issues: One group is putting together a locally resident "universal media library" supposed to reduce download times considerably and another is developing a more efficient *virtual reality transport protocol (VRTP).* Now defunct groups dealt with the streaming of *VRML* scene graphs and a "compressed binary format" of *VRML* files, which aimed at the fast transmission and fast parsing of such files. The "humanoid animation" group is attempting to enhance the representations of humans in *VRML,* whereas the defunct *Living Worlds* proposal aimed at the support of multi-user *VRML* applications. A few groups work in special areas of interest or on special issues, such as *CAD,* simulations, geo-referenced data, and multimedia integration – now defunct groups worked on biota and natural language processing. Recommended practices for *SQL* database access have been established through the work of a database group. At the time of writing, also a few of the mentioned non-defunct workgroups seem to have gone dormant. Some of the proposals are discussed in [RCRR+97].

1411 [Dame98] p. 19

1412 [Dame98] and [Powe97] provide excellent guides to these virtual worlds and to the elaborate terminology, the mores, and the etiquette that surround them. See also [Dame96], [VE98], [Sylw98], [Heud98], [Heud99a-b], [SZ99], and [Ande99]. See also http://www.virtual-worlds.net

1413 The mapping of photographs to avatar bodies was supported by *AvatarMaker 3D* from *Sven Technologies,* which company was acquired by *Spatial* in 1999 (see http://www.spatial.com). See [Dame98] p. 441 et seqq.

1414 Whereas the current generation of avatars tends to approximate the visual appearance of human beings in, at best, a very gross manner, the *Humanoid Animation Working Group* of the *Web3D Consortium* has made strides in the work on more realistic representations of

also by live "audio chat", provided the necessary software and hardware are in place.[1415] Besides by avatars, virtual worlds may be populated by various strange creatures such as *bots* (programmes that mimic human users/avatars, but are just programmes), *borgs* (programmes that mimic human users, but generally are not, although they may at times be piloted by humans), *agents* (programmes acting on behalf of humans), *biota* (programmes mimicking animal or plant life by implementing ideas from the research on artificial life), *biots* (programmes that mimic animals, but interact with users more directly than biota), and *virtual pets* (a subspecies of biots acting like pets).[1416] Occasionally, avatars may *teleport* between different worlds or between different parts of a world, typically by entering a gateway or a door referred to as a *portal* or a *wormhole*.

Soon after the arrival of *VRML 2.0*, two new significant 3-D technologies were announced, *Sun's Java 3D*[1417] and *Microsoft's XML*-based *Chromeffects* (originally code-named *Chrome).*[1418] Although none of these was positioned as a replacement of *VRML* and *Chromeffects,* having met with only lukewarm response amongst software developers, was soon mothballed by *Microsoft*[1419], their arrival floated speculations about the future of *VRML* being considerably less bright than previously believed[1420], thereby reinforcing the doubts about *VRML* instilled by its apparently stagnating growth in popularity on the web. Anyhow, their arrival seems to confirm that some major players deem it worthwhile to spend large resources on the development of web-related 3-D technology.

1.2.19 THREE-DIMENSIONALITY IN THE CRUCIBLE

For all the grandiloquent *VRML* euphoria and the manoeuvrings of the ever-truculent software colossi *Sun* and *Microsoft,* will really 3-D user interfaces, or *Visual User Interfaces (VUIs)* as some prefer to call them,[1421]

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humans and their movements, facial expression, gestures, etc. Some impressive examples of the result of this work may be studied at http://www.h-anim.org. Cf. also [RCRR+97] p. 119 et seqq.

[1415] [Dame98] p. 341 et seq.

[1416] See [Dame98] p. 394 et seqq.

[1417] See [Sun02b], [Sun97c-d], [Sun98a], [Sun99e], [SRD98], and Sun's *Java 3D* site http://java.sun.com/products/java-media/3D. [SD99] looks into how *Java 3D* can facilitate the programming of virtual reality applications. For example, the *Java 3D API* includes support for input from trackers and *6DOF* devices. [Sun98e] characterises the *Java 3D API* as a "fourth generation" 3D graphics *API* and compares it to, inter alia, *Open GL Scene Graph* and *VRML*.

[1418] See [Engs98], [Micr98a-c], [Kerv98], and [Ochs98]. Another similar technology is *MetaStream* from *MetaCreations Corporation* (now *Viewpoint Corporation).* Just like *VRML*, *MetaStream* defines a 3-D file format – a format that has been licensed by *Microsoft* for inclusion in the *DirectX* multimedia infrastructure (see [Micr98d]). A once promising product, providing detailed programmatic control of *VRML* content, was *Liquid Reality,* a *Java* toolkit from *Dimension X* intended for the construction of *VRML* applications (see [RCRR+97] p. 73 et seqq.). Since *Dimension X* was acquired by *Microsoft* in May 1997 (see [Micr97d]), little has, however, been heard of *Liquid Reality,* although *Liquid Motion,* a related technology intended for the animation of web pages, has been released as a product by *Microsoft*. Cf. also [HS98c] p. 640 et seqq. for an account of an interesting "VRML Bean" approach based on the combination of *JavaBeans* and the *Liquid Reality* toolkit. It appears that *Microsoft* largely has lost faith and interest in *VRML* and now, at best, pays lip service to it. For one thing, almost all significant *VRML*-related material on *Microsoft's* web site predates 1998. Additionally, in the 6.0 release of *DirectX* the support for importation of *VRML 1.0* files in *DirectAnimation* was removed, rather than updated to version 2.0 of *VRML* (see [Micr98f]), and, consequently, *DirectX 6.0* contains no immediate support of *VRML* at all. For more details about *DirectX* (version 5), see [BD98].

[1419] See [Fest98a-b], [Fole98c], [Fest99], and [Micr98y]. Some parts of *Chromeffects* were included in *Internet Explorer 5.0,* whereas others purportedly will be integrated with the *Windows API* "in a future version of the Windows operating system".

[1420] For example in [Pesc98b] and [Trot98a]. In contrast to *VRML*, *Java 3D* is an *API* and not a file format. Being web-compatible by virtue of its *Java* foundation, it has an edge in web applications over established *APIs,* such as *OpenGL* and *DirectX*. As a potential competitor to *VRML*, it, however, seems to be handicapped by being an *API* rather than a file format.

The *XML*-based *Chromeffects* was intended not for the construction of immersive virtual environments, but for the enhancement of web pages with 3-D features. At any rate, *Microsoft* already provides both rich 3-D *APIs* and a 3-D modelling file format (.x files) of its own making as parts of the *DirectX* technology. See http://www.microsoft.com/windows/directx.

Some years ago, the proliferation of 3-D technologies and 3-D *APIs* was believed to become mitigated by the *Fahrenheit* effort pursued by *Microsoft, Silicon Graphics* and some other companies in order to coalesce *OpenGL* and *DirectX* into one set of *APIs,* backwards-compatible with *DirectX* and "functionally compatible" with *OpenGL*. Besides a *Low Level API, Fahrenheit* was meant to include high-level *Scene Graph* and *Large Model Visualization APIs,* originally scheduled for release in 1999. In mid-1999, *Silicon Graphics,* however, chose to abandon the project, thereby bringing the entire effort to an end. See http://www.microsoft.com/directx/overview/future/fahrenheit.asp, [Micr97t], [Shan99], [Fest99], [Sili00], and [Lett99a-b].

[1421] [SS98b]

ever overstep the boundaries of entertainment and chat software and some other niches where their usefulness is evident? Will we ever see 3-D operating systems and mainstream 3-D business software? Beyond superficial flashiness, are there any substantial advantages to be gained by a 3-D interface in terms of usability, flexibility, comprehensibility, and other qualities frequently asked for? Various objections to a 3-D user interface come to mind immediately.

Firstly, performance currently remains a serious problem, in particular if the appropriate video hardware and processor power are absent. Performance is largely a function of the complexity of the 3-D images – a fact, which tends to hamper realism and the level of detail displayed on the screen. As hardware and software improve, we may expect these problems to dwindle, although they will certainly not vanish altogether – ordinary 2-D *GUIs* are still often tantalisingly slow even on very fast hardware, and the tendency of software to grow more complex – and thus slower – seems to keep pace with or, at times, even outpace the hardware performance enhancements! In any case, the rapid evolution of graphics hardware, largely consequential upon the demand for increasingly sophisticated 3-D video games, is now about to make massive 3-D rendering capabilities available also on comparatively inexpensive desktop machines.[1422]

Secondly, 3-D navigation is generally recognised to be difficult, and current input devices clearly need to be accommodated to the demands of three dimensions or to be supplemented or replaced by input machinery better suited to the task.[1423] For example, the wheels available on some present-day mice may be used to good advantage for navigational purposes in a 3-D world, and to handle the increased complexity of 3-D navigation and avatar control it may be a good idea to add even more wheels, buttons, and the like to input devices.[1424]

1422 [Ozer98a-b] and [Case99] give some particulars on the state-of-the-art of graphics cards in 1998-99. Cf. also [Inte98a-b] and [Inte00] for a briefing on *Intense3D's Wildcat* technology, which at this time offered rendering capabilities of up to 20 million triangles per second on *Windows NT* workstations. This level of performance was claimed to be sufficient for real-time rendering of very complex, photo-realistic, high-resolution animations and to surpass or equal that of the current generation of very expensive high-end *UNIX* graphics workstations. The latest incarnation of the *Wildcat* technology, *3Dlabs Wildcat 4 7210,* reportedly allows a performance of up to 37.9 million triangles per second (see [3Dla02]), whereas, according to [Sili02], Silicon Graphics latest monster machine *Onyx 3000* claims a performance of 283 million triangles per second. Cf. also [Rhei91] p. 168, where Alvy Ray Smith is quoted as stating that "reality is 80 million polygons per second". Additionally, low-cost 3-D accelerators targeting the gaming market (using chip sets from companies such as *nVidia, S3, 3Dfx, Matrox,* or *ATI)* are currently about to reach a level of performance not too far from that of the *Wildcat*. See, for example, [Pesc01] and [Obri01] on *Microsoft's Xbox*. In fact, Moore's law is currently reported to be outpaced by the developments of graphics hardware; [Case99] avers that "for the past three years, the computational power of graphics chips has increased eightfold every 18 months". See also [Stan99a] for performance benchmarks of some high-end graphics workstations. More recent graphical benchmark results can be found at http://www.specbench.org. Hardware developments have always been of crucial importance for the formation of our digital visions. As pointed out in [BGBS95] p. 36, the development of the transistor and integrated circuit (as well as the disappearance of the vacuum tube) formed the foil against which Licklider, Sutherland, and others could define a new paradigm of computing in the early 60s.

1423 Oddly, [Norm98] p. 100 et seqq. sees a major obstacle to 3-D user interfaces in the risk that they will cause nausea with some viewers. More pertinently, [GN96] p. 72, takes some early 3-D designs *(Microsoft's Bob* and *Apple's Magic Cap)* to task for introducing "a level of clunky indirectness in achieving common user goals" and for being "navigationally" and "interactionally cumbersome".

1424 Current I/O devices may be enhanced in many ways to better support the needs of 3-D *GUIs*. Small, separate displays sensitive to pointing could be used as bird's-eye views, toolboxes, and the like in order not to clutter the main display unnecessarily – such displays could, for example, be located in the empty space at the upper rim of the keyboard. Good use may also be made of multiple (flat) screens to support simultaneous activity in different virtual *rooms* or the observation of the same *room* from multiple angles. Mouse, joystick, and keyboard may suffice for the control of a simple cursor on a flat 2-D desktop, but seem inadequate for the much more complex control of avatars. Probably, special avatar controllers will be needed, equipped with some smart combination of keys, buttons, wheels, trackballs, and levers that will make it feasible – and hopefully easy and intuitive as well – to control 3-D motion, 3-D object manipulation, avatar face expressions, etc. Certainly, much can be learnt from the design of the intricate "joy pads" and "action pads" used in computer gaming. Interestingly, some game pads adopt a car driving metaphor by providing a steering wheel, a gear-lever, accelerator and brake pedals, etc., whereas others use a flight yoke and rudder pedals to mimic the flying of aeroplanes. Cf. also [AB92b], who survey a plethora of 3-D interaction devices, [KNU97], who describe a "virtual ceramic art work environment", [BG93], who discuss gesture recognition techniques and *virtual tools,* i.e. 3-D objects that "encapsulate a visual appearance and a behavior to control and display information about application objects", and [Epla98] and [Bowm99], who give some inklings of *E-Planet's* video camera-based software for hand signalling. [Turk98], reproaching present-day computers for being "essentially deaf, dumb, and blind", and [Dam97] survey various technology developments that may be drawn on for the realisation of a multimodal *perceptual user interface (PUI),* including work on head, body, and eye tracking, gesture and speech recognition, and biofeedback as well as haptic interfaces that utilise both the human tactile (touch) and the kinaesthetic (balance/motion) senses for feedback (see also http://www.cs.ucsb.edu/conferences/PUI and [Rhei91] p. 222 et seqq.). Cf. also [Zett96] p. 88 et seq. for some astute observations on the need for kinaesthetic feedback in order to make simulations convincing, [Rhei91] p. 27 et seq. for a discussion of haptic interaction and human *proprioception* (the complex system of internal sensors and effectors in muscles and at joints inside the human body), and Ted Nelson's ideas about *fantic unification* and *fantic controls* in [Nels73] p. M24.

Navigation will be much simplified, if avatars are restricted to move on the ground by default – people are not accustomed to flying around in the air in real life, nor is such motion generally of great use in virtual worlds.

Disorientation and occlusion are other problems, which, however, may be considerably alleviated by good design and the addition of maps, shortcuts, menus, and well-designed search capabilities. As in real life, it is far more difficult to get lost in a room or a small apartment than in a huge castle or a city, to say nothing of a whole world. For many users, a simple 3-D office-room metaphor would cover most of their computing needs, and, consequently, they would only very occasionally need to go beyond the walls of this room, where they should learn to find their way soon enough.

Provided acceptable performance can be attained, there are many advantages to the 3-D approach. Firstly, realism in metaphor will enhance comprehensibility and make for conceptual integrity. Secondly, objects are more easily organised in an orderly and perspicuous way in three dimensions, as is demonstrated by, for example, the frequent need for clearing up physical as well as computerised desktops. The work of the *Xerox PARC* user interface group and others has demonstrated how 3-D information visualisations may be used to present data in new and thought-provoking ways.[1425] 3-D techniques may also be taken advantage of for the somewhat more mundane tasks of preserving precious screen estate and increasing the density of objects per area.

For all those benefits, what in our view may make 3-D user interfaces worth a king's ransom is, however, the synergy effected by introducing *Newi*-style *business objects* into them. Whereas today's *Internet*-based *virtual worlds* provide little more than drab and hollow 3-D Potemkin labyrinths, devoid of any useful function[1426] and haunted almost exclusively by witless teenage chatterboxes, the addition of business-oriented functionality seems required in order to transform them into something truly useful. *Business objects* basically represent a strong push for *realism* in the models used to represent the outer world inside a computer, and so indeed does a 3-D user interface. When combined, loosely coupled *business objects* and *virtual worlds* have the potential to change the ways of computing as fundamentally as the introduction of the *GUI* did, nay, to form the foundation of a new era of *realistic computing*. In particular, this will be the case, if something like the *Taligent* compartmentalisation into people, places, and things is brought to bear on the resulting 3-D user interface.[1427]

1.2.20 TOWARDS A 3-D OBJECT-ORIENTED USER INTERFACE

A simple experiment may give an inkling of what can be done and how the 3-D *GUI* of tomorrow may appear to its users. On a PC with *Microsoft's Active Desktop* installed and enabled, it will be possible to set up a web page as the *Windows* background. This web page may of course be locally resident as well as remote, and it may contain anything a regular web page can, including a *VRML* world, provided a *VRML Internet Explorer plug-in* has been installed.[1428] If such a *VRML* background is created and the ordinary desktop icons are replaced with 3-D objects linked to the documents, applications, web pages, etc. that these icons used to represent, a primitive 3-D user interface to the computer has in effect been created. The user may walk around inside this virtual world, which may depict an office room, the parlour of Louis XIV, a scene from Dante's *Inferno,* or whatever the user may prefer, and activate the various items by clicking on their 3-D representatives.

[1425] Cf. [SP97b] p. 44, where Ben Shneiderman declares *information visualisation* the direction in which the future is moving. The power of a 3-D organisation of data is also vindicated by the use made of "memory palaces" and "memory theatres" in the ancient "art of memory" in order to enhance human memory. See [Yate66].

[1426] Some work has been done on simulating intelligent behaviour and suchlike in 3-D *agents*. See e.g. [TCRM+96], [BS96a], [RCC98], and [RHMT+98]. Cf. also [Dame98] p. 397 et seqq. A workshop on business applications of virtual reality was recently held in conjunction with the *BIS 2002 (Business Information Systems 2002)* conference in Poznan; see http://bis.kie.ae.poznan.pl/5th_bis/workshops/bavr.htm and http://bis.kie.ae.poznan.pl/5th_bis/5_program.htm#BAVR.

[1427] [CP95] p. 75 et seqq. [Leev98] describes a desktop VR system somewhat in the vein of *Taligent's* user interface. This system is based on a *cycle of cognition* that consists of six "modes of communication", *home, map, landscape, room, table,* and *theatre,* tailored to the needs of an idealised working day. Cf. also [HTKO+97], where a prototypical 3-D home office environment is described, although the primary concern of this paper is with the office as a *collaborative environment*.

[1428] Some *VRML* plug-ins such as the *Cosmo Player* behave less gracefully in this mode of operation, interfering with channels and other active desktop content. *Blaxxun ccpro* works fine.

Upon application activation, the 3-D metaphor will, of course, break down – *Word, Excel, PowerPoint, Internet Explorer,* or *Visual Studio* will all appear in their well-known, pedestrian 2-D disguise.

Doubtless, this experiment spotlights the deficiencies of the current state of the technology. First and foremost, better ways to integrate external functionality into a 3-D world are clearly needed. A *Word* document, an *Excel* spreadsheet, or any John Doe or Richard Roe business object should – probably after some negotiation to set its bounds – be able to render itself realistically in a standardised way inside the 3-D space allotted to it.[1429] Also the continuously changing data of news and stock tickers will need to be rendered in a standard way in a 3-D world. Furthermore, it would be nice to be able to flip through the pages of a multi-page document just as is possible in *Xerox' WebBook.*[1430] Support for *compound documents* and *drag-and-drop* interactions will be needed no less in a 3-D world than in a 2-D one, and it should be possible to edit documents directly *in situ* when in 3-D mode, without having the 3-D illusion spoilt by a wealth of non-3-D paraphernalia, such as 2-D menus, 2-D buttons, or 2-D toolboxes, although realistic 3-D tools and widgets will, of course, be perfectly acceptable.[1431]

For some tasks that are inherently two-dimensional, such as text editing or forms fill-in, it will be necessary to be able to change over to 2-D mode as well, although this should be done in a way that preserves the 3-D illusion as far as possible.[1432] By the use of a smooth and realistic animation sequence, the shift from 3-D display to 2-D editing may, for example, be effected so as to create an impression of the user's avatar stooping down over the document to be edited. At times, it would be preferable to have the document displayed on a separate (paper-sized) pad, over which the user himself – rather than his avatar – may stoop down using a pen or a keyboard for direct interaction with the document.[1433] For a complex editor such as *Word,* probably only a fraction of the full functionality available in 2-D mode will be present when 3-D *in situ* editing is resorted to, although the basic text editing operations should always be available.

Earlier, we have argued that a business object infrastructure should be built on top of a component infrastructure, such as *COM* or *.NET*. In the ordinary 2-D *Windows GUI*, components and applications support complex interoperations such as drag-and-drop and various aspects of compound document management, including screen estate and menu-bar negotiation and *in situ* editing, by implementing pre-defined *COM* interfaces. Additionally, a sizeable market for *ActiveX* controls, most of which are related to the user interface, has emerged, and the extensive reuse of prefabricated *ActiveX* controls is widely recognised as a way to shorten development times significantly. Hence, it seems sensible to ask: May *COM*/*ActiveX* or *.NET* be used as a basis for 3-D user interfaces?

1429 The *Browser API* of the *VRML* script nodes includes the functions *createVRMLFromURL* and *createVRMLFromString,* which may be used to load an externally defined description of a 3-D object into the current *VRML* scene from a script. To make a simple 3-D icon of a document, a bitmap copy of the document (or probably rather the first page of it) will have to be made. This bitmap must then be texture-mapped onto a *VRML* node that defines the shape of the object. This node, in turn, will have to be connected to a likewise hand-crafted script node implementing a script that loads the document together with its corresponding application programme, when the user clicks on the 3-D icon. Although not difficult, the creation of such an icon is an awkward and complex process. Cf. [RCRR+97] p. 50 et seq. and [HW96] p. 156 et seq. [Mace98] describes how some developments in *Microsoft's DirectX* technology may make it possible to merge 2-D and 3-D graphics and "to perform 3-D transformations on Windows and to have windows that are partially transparent". [RDR99] briefly describes *Task Gallery,* a 3-D user interface featuring a gallery or hallway metaphor, designed by the user interface group of *Microsoft Research* as a replacement of the traditional *Windows* desktop. Cf. also [Ball99]. [Micr99f] outlines the feature set of *GDI+, Microsoft's* latest incarnation of the *Graphics Device Interface,* including various items needed for a 3-D user interface, such as *Task Gallery*. For one thing, the readability of text in 3-D display mode is enhanced in *GDI+*.

1430 See [CRY96]. At http://www.microsoft.com/directx/dxm/help/da/frameset/Tutorial_main.htm, an example of a photo album supporting such page flipping through the *DirectAnimation API* of *Microsoft's DirectX* is provided.

1431 Cf. [Dam97] and [Dam98]. Universally applicable tools, such as the *cursor tools* of *People, Places, and Things,* will be particularly appropriate. See above p. 266 and [CP95] p. 98 et seqq.

1432 Generally speaking, a new technology that is capable of enshrining its predecessor completely by the emulation of its feature set should have better prospects than one that is not, effectively defusing any objections that arise from backwards-compatibility or nostalgic concerns. For instance, the *UNIX* and *Windows NT GUIs* support the execution of text-based software and operating system commands in separate windows. [BG99] attempts to chart the logic of such phenomena of *remediation.*

1433 Cf. [Lick60]. Support for multiple monitors finally made its way into *Windows* as part of *DirectX 6.0* (see [Micr98e]). A technical discussion hereof can be found in [Camp97a].

The *V-Worlds* software (also referred to as *Virtual Worlds)* at *Microsoft Research* is a *COM*-based research platform for building virtual worlds.[1434] This platform was earlier available for download over the web free of charge for non-commercial use, but never became a real product. Although the kind of advanced integration we asked for above was not supported by *V-Worlds,* every 3-D object in *V-Worlds* was a *COM* object, which implemented a *COM* interface called *IThing*. The *IThing* interface supported:

- run-time addition and deletion of properties and methods
- access of methods and properties, including inherited features
- object persistence through serialisation

Thus, *V-Worlds* supported *live editing* of content, including not only the dynamic addition and deletion of 3-D objects themselves and the modification of their property values, but also the dynamic addition and deletion of the *methods* and *properties* of such objects. Furthermore, implementation inheritance between classes called *exemplars* was supported[1435], and any 3-D object could be promoted into an *exemplar,* which might then be used as a prototype for the instantiation of new objects or as a base class to be inherited from.[1436] As with business objects, binding was done at run-time, and properties and methods were searched in the following order: 1) in the object itself 2) in the exemplar of the object 3) in the superclass of the exemplar, and then in its superclass, and so on until no more superclasses remain. *Exemplars* were also objects in their own right and, thus, could be modified dynamically. All graphical objects inherited from either *Room, Artifact, Avatar,* or *Portal,* and these classes, in turn, were all derived from the base class *Thing*. In addition to a method *MoveInto,* which changed the current container of the object, *Thing* featured properties for the name of the object, its exemplar, its owner, its geometry definition, its container object, and its contents (as a list of objects), as well as a textual description of it. *Room, Artifact, Avatar,* and *Portal* added their own sets of methods and properties to those inherited from *Thing*.

V-Worlds objects could be accessed from *C++* or *Java* code through the rather daunting *COM* interfaces. Since the 3-D objects were supposed to implement the *IDispatch* interface in addition to *IThing*, they could, however, be more easily accessed from *Visual Basic* and scripting languages that support *Automation*. *V-Worlds* was based on a client/server architecture: Its objects were inherently distributed and in most cases would be cached in the client machines for performance reasons. Since this caching mechanism required one-to-many communication for updates, *DCOM,* being a one-to-one protocol, could not be used. Provision was made for the persistence of objects (through object serialisation), logging, and security. *DirectX* was used for the display of graphics, and the scene graphs were defined in the *DirectX .x* file format.[1437]

From a business object perspective, it seems preferable to include the graphical model of an object as a property in the object itself as was done in *V-Worlds* rather than to make the graphical model include object behaviour or interface externally defined behaviour, as is the approach of *VRML*. This is a question of perspective: In *VRML,* the *visual model* itself is the cynosure of all eyes, and behaviour is regarded as an add-on of

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[1434] See [VMMD98] and the *V-Worlds* web sites http://www.research.microsoft.com/vwg, http://vworlds.research.microsoft.com, and http://www.vworlds.org. See also http://www.research.microsoft.com/scg. The *COM* foundation set *V-Worlds* apart from other proposed multi-user virtual world infrastructures such as the *Java/C-based Open Community API* (see [AGMM+96] and [WA97]) and the *VRML*-based *Living Worlds* (see [HMRR98]). Additionally, both these technologies are proposals for "open standards", whereas *V-Worlds* was but a *Microsoft* research project, which, however, might well have developed into a "de facto standard", if *Microsoft* had chosen to make a product of it.

[1435] As pointed out by [MHL95], also *VRML* objects support important aspects of the object-oriented model, including state and behaviour. [Bees97] advocates the use of object-oriented methodologies to cope with the complexities of *VRML* scene graph definition, and a working group of the *VRML* consortium is devoted to the task of making *VRML* more object-oriented (see http://www.cs.uni-sb.de/~diehl/ooevrml). [Dieh97] describes *VRML++,* a pre-processor-based *VRML* dialect that adds classes, multiple inheritance, dynamic binding, etc. to *VRML*. Another object-oriented dialect of *VRML* called *OO-VRML* is discussed in [PH97] and [PH98]. Cf. also [Riva97], [Bala99], and [WPJ01] p. 377 et seqq.

[1436] This approach seems somewhat akin to that chosen in Randall Smith's *exploratory programming* language *Self,* where objects (graphically represented as *morphs)* are created through the *cloning* of other objects, acting as *prototypes*. Such prototype cloning was also used in Smith's *Alternate Reality Kit,* a system for simulating and experimenting with the "natural laws" (represented by visible *interactor* objects) of 3-D "realities". See [SU95] and [Smit86]. In contrast to *V-Worlds,* both these systems are, however, *classless*. By the same token, [Bala99] advocates an evolution of *VRML* towards such a "prototype-instance" object model.

[1437] [Micr00]

secondary importance. In a business object approach, *behaviour* and *data* are what count and the *3-D* user interface is but one way of presentation, in addition to which others may exist as well. The use of component technology as a basis of *V-Worlds* also was interesting and may make the kind of tightly-knit integration we asked for above easier to bring about. The support for live editing, implementation inheritance, run-time binding, distribution, and persistence as well as their natural real-world correspondence made *V-Worlds* objects very close relatives of business objects, although they could have benefited greatly, I submit, from the addition of *Newi*-style semantic messaging and stand-alone executability.

1.2.21 CONCLUSION

Whether *VRML, V-Worlds*, or some other 3-D/multi-user technology is opted for, the intersection of 3-D user interface and business object technologies constitutes a hitherto almost entirely unexplored research territory. And the breakthrough in 3-D performance currently being about to happen should augur well for those venturing to enter this land of virtual milk and honey. In the *Panopeus* project, I have attempted to chart some small parts of this vast country under the lodestar of *realistic computing,* the proposed new agenda of computing – based on the combination of a 3-D user interface and *Newi*-style business objects –, of which an, admittedly somewhat sketchy, outline has now been given. But is this virtual Golconda seemingly brimming with diamonds really a land that we should set out for or is it a treacherous mirage that in the end will lure us into a desiccated desert haunted by the djinn of the abyss? This is the question that will be engaged in the next – and also, I contend, most significant – chapter of this work.

> *The most important means of regaining contact with reality is the recourse to thinkers of the past who had not yet lost reality, or who were engaged in the effort of regaining it.*
>
> *Eric Voegelin*[1438]

When I made up the plans for the Panopeus project some years ago, I thought it appropriate to conclude the work on the ideas presented in the previous sections by the implementation of some kind of simple prototype, thereby trying to demonstrate the feasibility of my own ideas about "realistic computing" according to the "proof of concept" model popular in computing Academe. As the time to embark on this more practical part of the Panopeus project drew nearer, my encounter with the philosophically strongly tinged literature on virtual reality had, however, already begun to instil into my mind serious doubts about the ethical benevolence both of my own, avowedly humble, contribution to computer science and, more generally, of the kind of Faustian endeavours, of which the field of virtual reality provides such a striking example. Additionally, although I was conversant with the well-known peculiarity of computer people to get 'religious' over such to an outsider apparently rather trifling issues as the preferable operating system, programming language, or text editor, I was also somewhat baffled about the pervasive religious, or perhaps rather pseudoreligious, overtones of the discourse on virtual reality, in particular as I became increasingly aware of to what extent this contagion had affected my own mode of thought and expression as well. Instead of embarking on the "proof of concept" work, about which I had now become profoundly ambiguous, I thus decided to try to come to terms with my own apprehensions by devoting the last part of the Panopeus project to a broader investigation into the issues that troubled me, the result of which will be presented below. In my view, such an investigation needs to address issues such as,

- What are the true roots of virtual reality?
- What is the real point of virtual reality?
- What is computing and computer technology really all about?

Such questions ineluctably spark off new, more general questions, which, additionally, need to be addressed before the first ones so as to be able to pave the way for a proper treatment and contemplation of the original issues. Such more primary questions are, for instance,

- What is science, really?
- What is technology, really?
- What are the roots of the Faustian spirit of Western science and technology?

Obviously, these grand issues largely lead us away from the topics conventionally studied in computer science into the realm of various metascientific and metatechnological disciplines – including the philosophy, history, sociology, and psychology of science, technology, and computing – and from these further on to philosophy proper, metaphysics, historiosophy[1439], and, in the end, theology (or, for the non-believer, some kind of surrogate atheology). Although it is widely recognised presently that the granulation and compartmentalisation of knowledge through self-imposed, essentially arbitrary disciplinary boundaries are both unnatural and deleterious, and, consequently, calls and suggestions for interdisciplinary research are heard almost everywhere, the actual implementations of the interdisciplinary agenda often only serve to create

[1438] [Voeg96] p. 95

[1439] By 'historiosophy' I designate any attempt to understand the grand pattern, point, or meaning of history, as distinct from the exploration of the actual data and facts that appertain to a certain historical event. Christian salvational history, Hegel's theory about the evolution of the *Weltgeist,* the Marxian dogma of class struggle, Darwinist evolutionism, the belief in scientific and technological progress, the Big Bang theory, and even statements such as "history has no meaning", "it is idle to search for grand patterns in history", or "Ichabod to meta-narratives" are all historiosophical doctrines.

small tunnels of idea exchange between two or a few realms of study rather than to lift the mind to a more overarching bird's-eye view of reality. In particular, such tunnelling efforts very seldom lead to a questioning of the fundamental metaphysical presuppositions that undergird and subtly shape the different disciplines as well as the scientific pursuit in its entirety or to a truly open discussion of how the disciplines involved relate to the "deeper" aspects of human existence and belief associated with the realms of religion, spirituality, theology, philosophy, metaphysics, ethics, and worldviews, but rather will tend to confirm the ingrained prejudices of the researchers and disciplines involved as to such issues. In the present study, I will argue that we need to go much further than creating such tunnels between different disciplines, that what we need to do is nothing less than to overcome the deep-seated fear of depth characteristic of Western science and technology.[1440]

As a matter of fact, it can be argued that the ban on deep perspectives in science – for a ban there certainly is, which, I believe, goes all the way back to the time, in the 17th century, when the agenda of modern science was forged, and which, albeit not originally being motivated by anti-religious and anti-metaphysical sentiments, but rather by a wish to overcome, or paper over, the religious-political rifts that had, seemingly at least, been instrumental in fomenting the 'religious' wars that had ravaged this century, later was widely mistaken for the scientific attitude proper and was consequently radicalised into 'scientific materialism', positivism, and other kindred isms – has made science superficial, unreflective, unrealistic, unethical, and profoundly insensitive to the most fundamental aspects of human existence, and that these very failings of science – and to be sure technology as well – are very much at the root of the current plight of the world and the alarming, seemingly insuperable problems and extraordinarily troubling prospects that now face mankind. Over time these inauspicious attitudes have, alas, been strongly reinforced by the myopia that naturally ensues from the ever-increasing specialism and enormous fragmentation of science, thereby further obscuring the significance of the metaphysical and religious presuppositions that in subtle ways precondition all attempts to gain knowledge about reality and making the pursuit of science and technology look more and more like a futile and extremely dangerous race in a maze, in which the modern mind has somehow been locked up, unable to find any egress or to see beyond the walls of the labyrinth.

If the present chapter already begins to read like an exercise in iconoclasm, as it certainly to some extent will be, it is, however, an iconoclasm that is inspirited not by a general anarchic rebelliousness against all and everyone, but by a desire to find and recover – sit venia verbo – the reality and proper perspective, the truth about being, and the link to the wellsprings of reality that somehow slipped or were stolen away during the dance around the scientific, technological, political, economic, and various other gold calves, about which mankind has been gambolling and romping so fervently for a number of centuries now. Thus, rather than an exercise in iconoclasm I should like this study to be an exercise in idoloclasm, that is to say an attempt to dispose of some of the false gods, who, I have come to conclude, fundamentally distort our understanding of ourselves and the world – as well as of the true import and implications of science, technology, and computers. More specifically, this idoloclasm will largely concern the kind of worldview and strain of thought represented in Sweden by figures such as Hägerström and Hedenius, whose ideas, once impressing me greatly and still providing much of the tacit philosophical underpinnings of the modern Swedish society, I can now but construe as maleficent verbal sorcery. I take it as a matter of course that such an effort to smash idols in order to regain the 'something' that has been lost will not be possible without my occasionally expressing views and conclusions that will be highly unpalatable to some and angrily disputed by others, and in particular so by those who, while still worshipping the idols I set out to smash, consider this loss a gain.

To accomplish the task loosely outlined above, I will, somewhat in the spirit of the celebrated 'hermeneutic circle', try to use a method of stepping further and further back – both along the historical timeline and across the borders of disciplines – in order to get the proper perspective of the topics studied and, thus, become able to identify the spots worth stepping forward towards, stooping over, and examining and

[1440] Judging from what I have learnt by reading rather than from what I have actually experienced myself, many scientists and engineers may when such topics are brought on the table begin to feel ill at ease and may even become peevish or fractious, perhaps feeling inclined to clamour about this or that not being science or about the necessity to stick to the last of (computer) science proper. In the following, I will disregard the various expressions of such Svengali mentality, to name this disturbing phenomenon by its rightful name, as ultimately such an unlikable, uncivil, and narrow-minded attitude only serves to impose one's own parochial beliefs on others through a kind of spiritual violence and to give the semblance of scientific authority to what is only one set of opinions out of many possible, and, at that, a set of opinions that, albeit perhaps still embraced by some scientists, is, as I will try to vindicate below, based on a profoundly discredited view of science as well as on metaphysical presuppositions of very questionable merit.

interpreting in detail so as to, by this process of criss-crossing, gradually attain a better understanding of the subject-matter at hand.[1441] A major difficulty of such an approach lies in the identification of the point where to stop stepping further back, as there always seem to remain significant ulterior presuppositions, on which our theories rest, and a wider context, in which these are inextricably entwined and interwoven. In particular, this will be the case if we wish to understand the roots and the rôle of computing in the intellectual history of our civilisation, come to terms with and evaluate some of the more extraordinary claims about this piece of machinery, such as those referred to as 'the strong programmes' of artificial intelligence, artificial life, and virtual reality, or pass judgement on the ethical aspects of these (and other) endeavours of 'technoscience'.[1442]

As already hinted at, we cannot hope to deal with such matters judiciously, let alone overcome the afore-mentioned problems of the fragmentation of scientific knowledge, unless we first work out a reasonably well-founded and well-timbered understanding of the sum of human experience, i.e. the world, ourselves, God, being, religion, science, culture, society, etc., which, in turn, will imply that a large number of diverse and intricate topics needs to be appropriately attended to. These topics, which will cross the boundaries of a plethora of disciplines and fields as well as the boundaries of time, insofar as they need to be considered also from a historical perspective in order to be rightly appreciated and dealt with, must be quarried, satisfactorily and systematically investigated, interpreted and constantly re-interpreted in the light of our deepening understanding in concert with the principle of hermeneutic circularity, and eventually integrated and organised into some kind of systematic conspectus or general *Weltanschauung,* or, possibly, into a small set of alternative systems of such kind.

Evidently, such Faustian polymath endeavours will, inter alia, run the risks of coming out shallow, premature, or one-sided, of growing intractably panoptic and pansophic in scope and content, or of becoming either lacking in unity or inordinately skewed by the philosophical, religious, political, metaphysical, and all kinds of other presuppositions, predilections, and taboos, which their originators may entertain. Even though the difficulties of such an effort may seem more insurmountable than ever in our age of ever-increasing specialisation and of enormous, rapidly-growing corpora of scientific and non-scientific lore and data and the consideration of the futility and ephemerality of many previous attempts of this kind may make us inclined to espouse the *□ποχή* of a resigned pyrrhonism, such enterprises, I believe, should not be dismissed out of hand, however preposterous and vainglorious their pursuance may appear, since if they are not ventured deliberately, critically, and openly, they will inevitably be made subconsciously, uncritically, and surreptitiously at even larger risks of gross errors, shallowness, misconceptions, and biased interpretations.

The starting-point of such an endeavour as well as the topics to be covered must be selected with great care, as these initial choices will indubitably influence the outcome of the enquiry decisively. For one thing, is the prospective investigator of such matters to use as a starting and primary vantage point a certain 'foundational' theory, science, or perspective? If so, how is this 'foundational theory' to be identified? Is it, just to name some of the options on hand, to be found in epistemology, ontology, metaphysics, philosophy of science, logic, mathematics, physics, cosmology, biology, brain physiology, cognitive science, psychology, parapsychology, sociology, anthropology, (comparative) religion, hermeneutics, linguistics, history, philosophy, theology, mysticism, or some other realm, or perhaps in a blend of some or all of these? But will not the espousal of a single basic perspective lead into the kind of reductionist distortions referred to by labels such as mathematicism, logicism, physicalism, biologism, cognitivism, psychologism, sociologism, historicism, etc.? Would it be possible, or at least desirable, to create instead some kind of universal synthesis of all relevant strains of knowledge, something like the *pansophy,* which Patrizi, Comenius, Behmen, and others boldly envisioned about 400 years ago?[1443] Will it really be feasible at all to find a reasonable, neutral starting-point,

[1441] Gadamer's ideas about horizons of interpretation and their merging – *Verschmelzung der Horizonte* – as well as Lonergan's investigations of how we gain insight (see [Lone70]) will be germane to the proper understanding of this kind of methodology. A compendious presentation of Gadamer's philosophy is provided in [Lübc87] p. 163 et seqq. On Lonergan, see [Crow92]. On reflexivity in general, viewed from the point of view of the sociology of knowledge, see [Ashm89]. [Braw00] offers some interesting reflections on the value and dangers of dissentient aloofness.

[1442] The somewhat awkward, but very handy term *technoscience,* coined by Bruno Latour (in [Lato87] p. 174), will be used here to signify all aspects of the symbiotic complex of technology and science, so pre-dominant in the modern world. Cf. also [Viri00] p. 1.

[1443] See [Walk20], [Leij98], [Henr79], [Peuc67], [Kris64] p. 110 et seqq., [□erv70], [Colp99] p. 115 et seqq., [Mont71] p. 151 et seqq., [Lind75] vol. II p. 161 et seqq., [Ross00] p. 130 et seqq., and [Week91] p. 48 et seqq. On the importance of Raymond Lull's *ars generalis* for the gestation of the pansophic programme, see [Ross00] p. 38, where the allure of pansophy is thus neatly summed up: "In the 'pansophic ideal' which dominated seventeenth-century culture there was an insistence both on the necessity of possessing total knowledge, and on

which does not predispose us towards certain conclusions and distort our judgement and understanding of the world fatally? And is it at all possible to arrive at the truth by sifting the evidence in some kind of rational, unbiased mega-analysis, as is the position of the *evidentialist,* or will not our conclusions always be fundamentally determined by pre-rational commitments or acts of faith, as the *presuppositionalist* contends? Is the real truth about cosmos and being rather to be found through religious or mystical exercises, experiences, and/or studies? Are we, in short, rather than to attempt in vain to honour the mirage of some kind of dispassionate scientific objectivity, to take our departure in one or other extra-scientific religious, philosophical, esoteric, political, or ideological doctrine? But how are we then to determine which such doctrine to opt for in an increasingly pluralistic era, when there is no want of such doctrines that claim to be the, possibly exclusive, path to the truth? Is not the idea that man by his own making – individually or in some kind of collective effort, such as science – can arrive at important truths or even at an all-encompassing system of truths through painstaking studies and disciplined thinking suspect, naïve, and preposterously conceited, nay the root of all heresies?[1444] Must there not at least be some truth in the *presuppositionalist* viewpoint, as, otherwise, most reasonably honest and intelligent people, living in the same reality, would presumably arrive at the same or at least similar conclusions, which hardly is an idea reconcilable with the history of thought and the present state of intellectual and spiritual diversity and disorientation? Additionally, does not history teach us that all human attempts to reach truth – scientific as well as extra-scientific – will sooner or later become obsolete? Is, perhaps, a more timeless kind of truth to be found in one of mankind's great religious-revelatory traditions, such as Catholic or Eastern Orthodox Christianity? Or may historical relativism be overcome by the appealing idea, suggested by Steuco in the 16th century[1445] and revived by the neo-Thomists, C. S. Lewis, Aldous Huxley, Tage Lindbom, and others more recently, of a *philosophia perennis,* either interpreted as the metaphysical and ethical core of the great tradition of philosophy taught by such distinguished thinkers as Plato, Aristotle, the principal Fathers, and St. Thomas Aquinas[1446] or – in a more speculative vein – as an ethico- or mystico-philosophical wisdom common to the sages of all peoples, all religions, and all ages[1447]?

For now, I will suspend judgement on these admittedly important and vexing issues, to which I certainly do not claim to have even tentative answers. Instead of the analytical, bottom-up approach implicit in most of them, I will here opt for an inductive, typological, top-down approach – actually also quite presuppositionalist in tenor – and try to use the concept *Weltanschauung* ("worldview") as my lodestar in navigating the muddy waters of human thought writ large and adumbrating a – by necessity tentative and impressionistic – critical survey and assessment of modernity, science, and technology in general and computing and computer science in particular.

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the existence of a single law, key or language which would enable one to read the alphabet impressed by the Creator in material things. For the pansophists the real world and the world of knowledge formed a unified and harmonious whole and shared an identical structure."

1444 After all, the meaning of the Greek word ***α□ρεσις***, from which "heresy" is derived, is (personal) "choice", "inclination" and, thus, "party", "sect". On the concept of "heresy", see also Hilaire Belloc's reflections in [Bell91] p. 1 et seqq.

1445 See [Loem73], [Schm66], [Pfis42], and [CS92] p. 184 et seqq.

1446 So e.g. [Gils99].

1447 So e.g. [Lewi96a] (who, however, calls this wisdom *Tao* rather than *philosophia perennis)*, [Aesc98] p. 70 et seqq., [Lind84], [Huxl70], [Schu93], and [Quin97]. For the notion of a *sapientia prisca* or *theologia prisca* (i.e. an ancient wisdom or theology that subsumes the core truths more or less well reflected in the traditional religions of today's world), once so popular within the tradition of Christian Platonism from Ficino and Pico to Ramsay and Herder, kept alive by theosophists, anthroposophists, and various other esotericists, and most recently revived in various 'New Age' writings, such as, for example, [Ashe77] and [Ross89], see [Walk72], [Rice58], [McKn91], and [Vond92]. Cf. also [SD77] and [Eisl10]. [Wass99] provides a somewhat grouchy survey of the perennialist school of the history of religion (i.e. such luminaries as Eliade, Scholem, and Corbin), taking these scholars to task for their one-sided emphasis on mysticism and disregard of other important aspects of religion, such as ethics. Writing from a theosophically tinged point of view, [Quin97] provides an unfortunately rather skimpy survey of the movement of traditionalist perennialism, the leading figures of which include René Guénon, Ananda Coomaraswamy, Frithjof Schuon, Titus Burckhardt, and Seyyed Hossein Nasr – and the most important Swedish proponent of which will have been Tage Lindbom. A brief, but perceptive and not unsympathetic Christian critique of Guénon can be found in [Dani68] p. 122 et seqq. A good treatment of the "Magdalen metaphysicals", to whom C. S. Lewis belonged, is provided in [Patr85].

3.1 TOWARDS A TYPOLOGY OF WORLDVIEWS

> *The commonplaces seem all the more to come close to the truth precisely because they are repeated at every turn with the air of assurance which would be appropriate to the expression of the truth if we possessed it, with a tone admitting of no dispute.*
>
> *Lev Shestov*[1448]

No one can dispute that science and technology set our times and our civilisation apart from all other times and civilisations, forming and incessantly re-forming both the material and the non-material aspects of human existence in the modern world from the ground up. Nor is anyone likely to take issue with the statement that science fundamentally and pervasively has shaped the modern worldview and brought about several major breaks with the different 'traditional' religious and philosophical ways of thought and belief once preponderant both in our own and in all other civilisations.[1449] Although the modern "scientific worldview" by no means is easy to define, at least not in detail, as science is a melting-pot of very diverse content, to which new ingredients are added all the time, while others, having evaporated from the cauldron in a cloud of mist, just vanish into thin air, and as, at that, this pot has solid compartments, between which substances tend to diffuse only slowly, if at all, there can nonetheless be little doubt about the general flavour of the brew currently spooned out to all and everyone through the educational systems, the mass media, the scientific literature, and the various other channels, through which it is distributed.[1450] However, as no soup can be successfully made without a recipe, one may be entitled to ask what the recipe of science is. What are its tacit assumptions[1451], 'metaphysical presuppositions'[1452], and 'supposals'[1453]? On what bedrock of philosophy does it rest, lending to it the tremendous respect and authority that it today commands?

Science, as all man's oeuvres, is an expression or objectivation of the life of the spirit, and, thus, by necessity embodies some kind of metaphysics or worldview that, flowing from spiritual sources within men, is more basic than the secondary metaphysics that *prima facie* appears to emerge from science as a result of its celebrated "findings" arrived at through what to a wide-eyed observer may appear as an objective process guarded by the rigorous discipline of the "scientific method", whereas, in actuality, a certain underlying primary worldview governs the general character of most present-day science, its methodological premises, and the secondary worldview, which appears to arise from the pursuit of science fortuitously and unexpectedly, as a genie out of a lamp. In later sections, I will go on to argue that this surreptitious, primary worldview regulating large parts of modern science – indeed, also a few islands of resistance exist – is fundamentally flawed, nay, that it rests on to all intents and purposes irrational, mistaken, and counterfactual beliefs about reality, that it consequently skews science in multifarious inauspicious ways and withal the outlook of the entire Western civilisation based on it, and, that it has in effect brought about a fundamental loss of reality rather than, as is widely taken for granted, a progressive advancement towards it. To underpin these possibly

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1448 [Shes70]

1449 For example, [Mazl93] suggests that there are four major "discontinuities" instrumental in giving shape to the modern conception of man, viz. Copernicus' heliocentrism, Darwin's theory of evolution, Freud's notion of man's serfdom under the dark drives of the unconscious, and the imminent breakthrough in artificial intelligence. These four discontinuities undermine, we are told, the ideas of man's separation from and domination over, in turn, the cosmos, the animals, the subconscious, and the machines. One may note that of these four, the factual basis of the three latter is highly contentious and that also the alleged effects on mankind's self-image of the first one are certainly not beyond dispute.

1450 Citing John Theodore Merz' history of 19th century science (see [Merz1903]), [Feye93] p. 243 et seqq. advocates the view that there is in science no such thing as a unified "scientific worldview", but rather a plethora of partial worldviews – something like Kuhn's "paradigms" – providing itineraries for further research. So, Merz in his study discusses "the astronomical view" (which was concerned with action at a distance), "the atomic view", "the kinetic and mechanic view" (which applied atomism to heat and electricity), "the physical view" (which focused on general concepts such as energy), "the morphological view", "the genetic view", "the psychophysical view", "the vitalistic view", and "the statistic view". Although the fragmentation of the scientific worldview has certainly not abated since then, all these fragmentary views are nonetheless, I contend, united and undergirded by a particular metaphysical agenda, which I will below refer to as the "primary worldview" of science.

1451 Cf. [Pola67].

1452 See [Burt99].

1453 "Supposal" is J. A. Smith's term for "hermeneutic ideas or principles supported by evidence" – see [Patr85] p. 128.

somewhat provocative and seemingly presumptuous contentions, we will first have to look into the concept of "worldviews" and some different classifications thereof that have been suggested.

In common usage, the term "worldview" signifies a kind of fundamental, inclusive, overarching comprehension of the world at large, acting as an overriding "whole" determining, organising, and bestowing unity on the more specific beliefs and views held.[1454] A worldview embodies an overall perspective, from which one sees and interprets the world, a perspective formed by a set of fundamental beliefs about man, life, God, the universe, and the meaning and value of it all – or the lack hereof – as well as by various volitional and emotional dispositions and attitudes towards existence. A worldview may be personal (Goethe's, Burke's, or Shakespeare's worldview) or appertain to some kind of larger unit than the individual, be it a culture (the ancient Greek, the modern, the Eskimo, or the primitive African worldview), a religion (the Christian, Roman Catholic, or Confucian worldview), a philosophy (the Platonic, Thomistic, existentialist, or postmodern worldview), a political ideology (the conservative, liberal, or Marxian worldview), a group of some kind (the worldview of the young, the farmers, computer people, or the disgruntled), or some other more loosely defined association (the mechanistic, Darwinist, holographic, scientific, or traditional worldview). In research, the term has been applied in the study of philosophy, religion, psychology, sociology, anthropology, economy, politics, literature, history, and kindred disciplines.[1455] Apparently, the concept of a worldview presupposes a certain degree of pluralism and often also some kind of relativism, that what Gilbert Murray and E. R. Dodds have called the "inherited conglomerate", the sedimentation of concepts and ideas that make up a traditional culture,[1456] has been broken up into competing structures or isms and that "to shop for a worldview", as it were, is a reasonable thing to do rather than just to adopt the faith of one's fathers and the surrounding society, as will presumably be the usual course in a traditional society.[1457]

There are some other terms that occasionally are used synonymously with the concept "worldview" and to which we, thus, may like to compare and contrast it. Some of the more interesting are:

[1454] See [Dilt84] p. 79 et seqq.

[1455] The vast literature – i.e. studies such as those presented in [HB96] and [LS98] – relating worldviews to these different specific domains need not concern us further here.

[1456] See [Dodd73a] p. 179.

[1457] Most terms denoting philosophical or theological standpoints ('isms') are of a rather recent vintage, being coined during the 18th and 19th centuries, or, in a few exceptional cases, in the 17th or even the 16th century – the latter include 'atheism', which, albeit a term used already in Classical Greek, fell into disuse during the Middle Ages and was reintroduced in the 16th century, 'Satanism', which started to be used as a synonym of atheism in the 16th century and received its modern connotations only through Robert Southey (1774-1843), 'deism' coined in the 16th century, 'theism' first used by Cudworth in 1678, and 'monotheism', 'Cartesianism', and 'materialist' invented by Henry More in 1660, 1662, and 1668, respectively (see [Lash96] p. 14, [Woot92] p. 25, [AW01] p. 217, and [Gabb99] p. 591). In the early 18th century, the English 'freethinker' (a term coined by Molyneux in a letter to Locke in 1647) John Toland invented the term 'pantheist', whereas 'panentheism' was coined by the German philosopher Krause in the early 19th century, 'nihilism' by Jacobi in 1799 (see [Coul92] p. 249), 'communism' by the pornographer Restif de la Bretonne in the 1790s (see [Bill80] p. 82), and 'agnosticism' by Thomas Huxley in 1869. 'Monism', 'dualism' (see [Stoy00] p. 2), 'pluralism', and 'materialism' appeared in the 18th century, whereas most terms for political isms ('liberalism', 'socialism', 'conservatism') were coined in the early 19th century (see [Bill80] p. 244 et seqq.), and 'anti-Semitism' in 1879 at the founding of the *Antisemitenliga* (see [Pipe97] p. 27). Although Herder had used the term 'nationalism' in a general, cultural sense in 1774, it was only in 1797 that it was applied by Abbé Barruel to the new national selfishness that was then about to replace Christian universalism (see [Bill80] p. 62). [Voeg78] calls such fixed positional stereotypes *egophanic symbolisms* (in contradistinction to the *noetic* and *pneumatic theophanies* of Greek philosophy and Christianity, respectively) and points out their innate tendency to fragment reality and, consequently, harden into dogmatically espoused distortions of reality.

Also during the 19th century the great non-Christian religions were made into isms, such as "Hinduism", "Buddhism", etc. (see [Tamb90] p. 5). It is also only in the 18th and 19th centuries that the idea of an evolution of religion from a primitive state of "animism", "fetishism", or "polytheism" towards "monotheism", metaphysics, and then science was worked out by Hume, Comte, Tylor, Frazer, and others. That the terminology emanating from such schematic and propagandistic conceptions has fundamentally distorted the understanding of the nature of religion (as well as its relations to metaphysics and science) and still does so, at least in the popular mind, seems indisputable. For example, a basic 'monotheism' (i.e. a belief in a Supreme Being, from which the world has emerged through creation or emanation) is generally not contrary or subsequent to a 'polytheistic' belief in a multiplicity of (lesser) divinities (occasionally even construed as different aspects, masks, or angelic split-offs of the single underlying divinity, somewhat similarly to the way the term "the Angel of the Lord", *angelus Domini,* may represent God – as the Second Person of the Trinity according to Christian belief – in some Old Testament passages, such as *Exod. 3:2),* or to 'animism' or 'fetishism' (see [Pett72] p. 81 et seqq.), nor does it generally clash with or antedate metaphysical speculation or scientific activities. Cf. also [Dodd70].

- *religion,* a conception of the world, by which man is related to the holy and the divine – as well as the social institutions, bodies, and associations, in which men of a common religious faith are united –, in general having a more authoritative and less individualistic character than a worldview, although the concept is also used simply to signify a personal or collective worldview that includes beliefs about the divine and the holy
- *ideology,* a doctrine, theory, or complex of ideas – typically of a political nature –, implicitly understood as polemical, dubious, or illusive in nature
- *philosophy,* a more systematic, rationalistic, argumentative, and reflective pursuit of the truth about the world, man, God, and being than what is usually implied by the term "worldview"
- *philodoxy,* Voegelin's byword for modern "philosophy", insofar as it is more concerned with the egophanic display of novel opinions than the open quest for truth
- *metaphysics,* the branch of philosophy that deals with i) being *qua* being, in particular the nature and essential characteristics as well as the different kinds and levels of being *(general metaphysics* or *ontology)* as well as with ii) natural philosophy, rational psychology, and natural theology *(special metaphysics)*
- *epistemology,* the branch of philosophy that concerns knowledge and its acquisition, possibility, and premises
- *paradigm,* Thomas Kuhn's designation for the predominating mode of understanding in a certain branch of science, its "disciplinary matrix" of basic assumptions, metaphysical commitments, and shared values, often applied also to extrascientific pursuits so as to signify any set of underlying, tacit assumptions that surreptitiously predetermine our worldview[1458]
- *belief-system,* a term closely related to worldview, stressing its irrationality
- *mentality,* the norms, values, habits, etc., from which someone's actions spring[1459]
- *climate of opinion,* a term, coined by Joseph Glanville and popularised by Whitehead, denoting the tacit consensus as to what is considered reasonable to discuss and, thus, providing the arena for the manipulative efforts of the modern mass media.

The above terms are in fact used in a large number of ways, which we do, however, not need to discuss here. We may also observe that in the German (and the Swedish) language there are four different concepts that roughly correspond to the English "worldview", viz.

- *Weltanschauung,* worldview proper, with an emphasis on the theoretical-ontological understanding of the foundation of the world, (e.g. "materialism", "dualism", or "idealism" in a primarily ontological-metaphysical sense)
- *Lebensanschauung,* "lifeview", often used synonymously with *Weltanschauung,* but with an added emphasis on the personal character and the practical-ethical implications of the views held (e.g. "materialism" and "idealism" as the ethical principles governing the actions, activities, and attitudes to others of an individual or a group)
- *Weltbild,* "physical worldview" or "world image", a conception of cosmos and man's place in it, presently – although this has not always been so – determined by science to a much larger extent than what men's *Weltanschauung* or *Lebensanschauung* are likely to be (e.g. the geocentric, heliocentric, or Big Bang world image)[1460]

[1458] See [Kuhn70]. On the multiple meanings of the term "paradigm" as used by Kuhn, see [Mast74].

[1459] See [LeGo78].

[1460] [Jasp94] p. 139 et seqq. uses the term "Weltbild" somewhat differently, distinguishing three main forms of it, "das sinnlich-räumliche Weltbild" (the interpretation of nature and the cosmos), "das seelisch-kulturelle Weltbild" (the understanding of human culture, history, and man himself), and "das metaphysische Weltbild" (the worldview of mythology-demonology and philosophy).

- *Weltformel,* a "world formula", i.e. an all-encompassing theory of matter and the laws of nature, to which the world can supposedly be reduced (e.g. the Newtonian or the Einsteinian world formula).

The literature on worldviews is enormous, at least if we include in this category all more comprehensive attempts to find out the truth about man, cosmos, God, and being and to chart and survey such endeavours. Also if we limit ourselves to works, of which the titles include the terms "worldview" or "Weltanschauung" and their various cognates and synonyms, we will have no want of literature. While most of these works are concerned with one particular worldview of this or that thinker, author, philosophical or ideological school, branch of science, political party, social group, culture, historical epoch, etc., there is also a much smaller set of literature of greater interest from the point of view of the present study, attempting to survey, scrutinise, and compare different worldviews more generally. Some of these works are didactic or exploratory in aim, setting out to chart the worldviews currently vying for men's souls in an apparently non-committal manner[1461], whereas others are openly polemic or apologetic in their aims, pitting different worldviews against each other with the objective to prove the pre-eminence of one of the worldviews discussed.[1462]

The English word "worldview" is of course a calque from the German *Weltanschauung,* which probably was coined by Kant in his *Kritik der Urteilskraft* and came into widespread use amongst German philosophers in the 19th century, during the period often referred to in Germany as the "decline of philosophy", when, after the demise of Romantic idealism, relativistic psychologising and historicising views became prominent in German philosophy. Around 1900 some German historians and philosophers, mostly of a relativist or eclectic cast of mind, tried to work out a more systematic *Weltanschauungslehre,* i.e. a typology of historically recurrent worldviews, or rather "ideal types" of worldviews, and some of them even equated this study with the proper task of philosophy. Leading figures in this endeavour were Wilhelm Dilthey, Eugen Dühring, Wilhelm Jerusalem, Heinrich Gomperz, Eduard Spranger, Karl Joël, Karl Jaspers, and Max Scheler.[1463]

The observation that there is amongst men a small number of fundamental philosophical or metaphysical attitudes is, however, very old. Already Plato, alluding to the myth of the gigantomachy, distinguished between the two basic attitudes of the *giants* (materialists), who identify being with matter, and the *gods* (idealists), who take the opposite view.[1464] In the late 18th century Fichte in his *Versuch einer neue Darstellung der Wissenschaftslehre* made a distinction between *dogmatists* (or *realists),* who attempt to explain everything, including ideas and consciousness, from objects or things and, thus, in the end tend to embrace causal determinism and fatalism, and *idealists,* who derive being and things from thought and, like Fichte himself, espouse freedom.[1465]

In contrast to Fichte, Jacobi, the great fideist and critic of all philosophical hubris and, in particular, Spinoza's, Kant's, Fichte's, and Schelling's system building, held *materialism* to be tantamount to *atheism* and *idealism* to *nihilism.* Instead, he drew a sharp division line between *naturalism* and *theism:*

1461 One example is provided by [Smar83], which is really an introductory, comparative survey of the great world religions – taking into account also such phenomena as Marxism, nationalism, and secular humanism – briefly discussing their doctrinal, mythical, ethical, ritual, experiential, and social dimensions. In [Gerz96], six "belief systems" or "states" dividing up America are discerned, to wit *Patria* (the Religious State), *Corporatia* (the Capitalist State), *Disia* (the Disempowered State), *Media* (the Superstate), *Gaia* (the Transformation State), and *Officia* (the Governing State). See also [Resc94].

1462 A number of such books written by present-day American Christian philosophers and apologists contrast various popular worldviews with that of Christianity: [Sire76] treats of Christian theism, deism, naturalism, nihilism, existentialism (both atheistic and theistic), Eastern pantheistic monism, and "the new consciousness (renamed "the New Age" in the third edition [Sire97], in which a chapter on postmodernism has been added as well as two subsections on secular humanism and Marxism in the chapter on naturalism), [GW84] (like its second edition [GW91]) compares theism, atheism, pantheism, pan-en-theism, deism, finite godism, and polytheism, [Spro97] contrasts secularism, pessimistic existentialism, sentimental humanism, pragmatism, positivism, pluralism/relativism, and hedonism to Christian faith, [Nash92] looks into and evaluates Christianity, naturalism, and the New Age movement, and [Noeb94] compares secular humanism, Marxism/Leninism, and Biblical Christianity from ten different viewpoints (theology, philosophy, ethics, biology, psychology, sociology, law, politics, economics, and history), considering what he calls "cosmic humanism" (i.e. New Age ideas) in an appendix. Also some advocates of non-Christian ideas take apologetic advantage of the world-view approach – for example, it is used to underpin New Age mysticism at the web site http://www.kheper.auz.com/topics/worldviews/index.htm.

1463 Significant contributions to the field of *Weltanschauungslehre* include [Dilt31], [Dühr1875], [Gomp1905], [Jasp94], [Spre25], [Høff25], [Joël28], [Hlu□ 29], and [Sche63].

1464 The famous passage is found in the *Sophist* 246A.

1465 [Fich1797]

> *Es kann nur zwei Hauptklassen von Philosophen geben: solche, welche das Vollkommenere aus dem Unvollkommeneren hervorgehen und allmählich sich entwickeln lassen; und solche, welche behaupten, das Vollkommenste sei zuerst und mit ihm und aus ihm beginne alles. Oder: es gehe nicht voraus als Anbeginn eine Natur der Dinge, sondern es gehe voraus und es sei der Anbeginn von allem: ein sittliches Prinzipium, eine mit Weisheit wollende und wirkende Intelligenz – ein Schöpfer-Gott.*[1466]

Although some will praise Jacobi's clear-sightedness, while others will animadvert on his denouncements of *idealism* as quibbling and meddlesome, as, for all his harsh words, the overlap between his own *theism* and the *idealism* of the Romantics seems, to the modern mind at least, substantial, or blame him for his lack of forbearance with their theosophical and theogonic speculations and attempts to reconcile *idealism* and *materialism* in some kind of a higher synthesis, it seems that history has proved his suspiciousness right: If the idealists were not themselves crypto-nihilists, as Jacobi held, many, and indeed some of the most influential, of their disciples indeed were.[1467]

In his often cited typology of worldviews, Wilhelm Dilthey, following Fichte rather than Jacobi, refers to the two aforementioned Fichtean ideal types as 1) *naturalism* or *materialism* and 2) *idealism of freedom,* respectively, but also adds yet another variant, which he calls 3) *objective idealism,* evidently intending it as a kind of compromise between the two extremes of materialism and idealism.[1468] This *objective idealism* differs from the *idealism of freedom* by representing the world as a meaningful, unified process determined by the ultimate *Weltgrund,* thereby, however, also limiting or giving up human freedom and leaning towards different forms of monism, pantheism, and panentheism, whereas 'freedom' of course is a key concept of the *idealism of freedom* and is here also made a property of the *Weltgrund* itself. Furthermore, Dilthey uses his scheme to classify various famous philosophers, including amongst the ranks of the *naturalists* Democritus, Lucretius, Epicurus, Hobbes, the Encyclopedists, "modern materialism", Comte, and Avenarius. To the *objective idealists* he counts Xenophanes, Heraclitus, Parmenides, the strict Stoa, Bruno, Spinoza, Leibniz, Shaftesbury, Herder, Goethe, Schelling, Schleiermacher, Hegel, and Schopenhauer, whereas he assigns Anaxagoras, Socrates, Plato, Aristotle, Cicero, the Christian philosophers, Descartes, Voltaire, Rousseau, Kant, Jacobi, Fichte, Maine de Biran and the other French spiritualists (including Bergson), and Carlyle to the category of the *idealists of freedom*. From this catalogue of philosophers, one may conclude that the division line between objective and freedom idealists is not always altogether clear-cut – for example, Schopenhauer with his strong emphasis on the will might, it seems, have qualified as an *idealists of freedom* as well.

A both more complex and more specialised phenomenology, but arguably also one being more truthful to life and, thus, in the end more useful, was suggested by the late Prof. Poortman in his erudite and fascinating

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[1466] Quoted from [Jaco26] p. 205.

[1467] The "pantheism" of Spinoza, who later became something of an icon to so many of the Romantics, including Goethe and Schleiermacher, was widely recognised as equivalent to atheism and naturalism (sometimes referred to as "Stratonical atheism" after the Peripatetic philosopher Strato of Lampsacus, who identified God with nature and deprived Him of consciousness) by his contemporaries (most notably by Henry More; see [Jaco91]), as well as by Jacobi during the notorious *Spinozismusstreit.* Kant, the relentless subjectivist *Allzermalmer* and Enlightenment hymnologist impugning the validity of the traditional proofs for the existence of God and reducing God to a moral postulate – thereby in effect presenting but a bulky epexegesis of the idea more pithily expressed by Voltaire's infamous dictum "si Dieu n'existait pas, il faudrait l'inventer" –, has likewise often been held suspect of deism or atheism (see e.g. [Moln78] p. 35 et seq., in particular note 38), although some dismiss such suspicions as unjustified (see [Palm93] and [Palm00]). The early, very Kantian views of his follower Fichte were similarly denounced as atheism by Jacobi during the *Atheismusstreit.* Furthermore, Hegel has, at least since his nihilist disciple Bruno Bauer's dissimulating attack on him in *Die Posaune des jüngsten Gerichts über Hegel den Atheisten und Antichristen,* repeatedly been held to be a closet atheist. In [Voeg71], Eric Voegelin offers a brilliant and distressing analysis of Hegel's deeper motifs and, in conclusion, exposes him as one in a series of megalomaniac, self-proclaimed 'gnostic' Messiases of a new post-Christian age presumed to have been inaugurated by the French revolution or some other ominous event of history. The club of such self-styled Messiases of the expected post-Christian age will include Saint-Simon, Comte, Marx, Freud, Darwin, Nietzsche (cf. [Bill80], [Luba71], and [Baum88]), and, more recently, Heidegger and, if we are to heed Richard Noll's momentous charges, C.G. Jung (see [Noll94], [Noll97], [Jone93] p. 153 et seqq., and [Gibb01] p. 103 et seqq.), the prophets of the advent of the era of technocracy, scientific positivism, classless communist society, pansexualism, nihilist pan-evolutionism, nihilist superman, being, and neo-pagan gnosis, respectively. In the same vein as Voegelin, [Gluc80] unmasks the egomania and fixation with power of the German "master thinkers", *les maîtres penseurs* (Fichte, Hegel, Marx, and Nietzsche). On the cult of the genius in Germany, see [Schm85]. Cf. also [Voeg97], and [Weis79].

[1468] [Dilt31] p. 87 et seqq. See also [Dilt14], [Dilt84], and [Dilt97].

magnum opus on "hylic pluralism". As I will repeatedly use his scheme in what follows, I will here comment amply on it in the footnotes. Poortman distinguishes six "metaphysical standpoints", named *Alpha* to *Zeta,* ranging from *monistic materialism* to *monistic idealism,* viz.:[1469]

1) *Alpha: monistic*[1470] *materialism,* i.e. the view that spatiotemporal 'matter' – and, notably, matter of a *single kind* only – is all that really exists, as is widely presumed, implicitly or explicitly, in most branches of science and most varieties of modern philosophy[1471]

2) *Beta:* the notion i) that only matter exists, although there are more than one kind of it *(hylic pluralism)* and ii) that the human soul – and possibly God and a *mundus imaginalis*[1472]

[1469] See [Poor78] part I p. 33 et seqq. et passim. *Hylic pluralism* signifies the notion that there are multiple kinds of matter. A similar, but more casually composed scheme is suggested in [Wies57] p. 57 et seq., where "materialistic monism", "trichotomism", "anthroposophy" (essentially an esotericist form of "trichotomism"), "scholastic philosophy", "extreme dualism", and "idealistic monism" are distinguished.

[1470] A distinction is often made between *substance* and *property monism/dualism/pluralism.* Whereas *substance monism/dualism/pluralism* designates the doctrine that there are one, two, or many substances in the universe, *property monism/dualism/pluralism* denotes the doctrine that there exist one, two, or many *kinds* of substances. Except for some substance monists, such as Spinoza and Hegel, often referred to or denounced as "pantheists", most philosophers have tended to be substance pluralists, whereas there is much more division over the question of how many *kinds* of substances there are. This latter issue is obviously the nub of Poortman's scheme of classification. On the importance of the definition of the term "substance" in this context, see footnote 1933 on p. 414 below. It should be noted that the term *property dualist* is sometimes also used as a designation for *supervenient materialism* or the *dual aspect theory* (see next footnote), although this usage will be avoided in the present study. In addition to *ontological monism/dualism/pluralism* concerned with substances, as just described, one occasionally lights upon the term *nomological monism/dualism/pluralism,* which instead refers to the number of the "sets of laws" which are found in the different realms of being.

[1471] In [Tali94b] p. 28 et seqq., Charles Taliaferro makes a distinction between *eliminative materialism,* the advocates of which flatly deny the existence of the mental, often referring to it as "folk psychology" and asserting that the mental is "nothing but" brain processes, and *identity materialism,* according to which the mental has some kind of shadowy reality, but can be reduced to or identified with the material. A somewhat softened form of materialism is what Taliaferro calls the *dual aspect theory* (other terms used are *supervenient materialism* and *feature* or *property dualism),* according to which only physical *objects* really exist, but some of these have non-physical, mental *properties.* Somewhat conventionally, he also classifies *epiphenomenalism,* i.e. the notion that the mental is a side effect or *epiphenomenon* of the brain processes, as a kind of dualism, whereas we will here take the view that this is better regarded as a variety of identity materialism.

Monistic materialism is often equated with *ontological naturalism* (as distinct from *epistemological* and *ethical naturalism),* i.e. the view that everything that exists can be reduced to ("reductionism") the "natural" spatiotemporal causes and concepts studied and used by the natural sciences ("scientism") and that nothing "supernatural" exists. The most common variety of naturalism will be *physicalism,* which equates reality with the entities studied by physics, but other varieties exist as well, as, for example, the *biologism* of the neo-Darwinists. As observed by [CM00] p. xii, we may distinguish from the *strong naturalism* typically couched as reductionist physicalism a *weak naturalism* that softens the naturalist stance by taking into account "emergent" properties and entities of a higher order than that of physics *(tout court,* "holism" of one kind or other).

Naturalism and monistic materialism are usually combined with *determinism,* i.e. the denial of the free will, and *atheism,* the denial of the existence of God. The Cambridge Platonist Ralph Cudworth in his now largely forgotten, but once very influential *True Intellectual System of the Universe* made an interesting distinction between four major varieties of atheism, viz. 1) "Hylopathian or Anaximandrian", according to which all things, including life and understanding, are to be derived from dead matter as qualities and forms (advocated by e.g. naturalistic Aristotelians, such as Pomponazzi), 2) "Atomical or Democritical", which derives everything from bare matter as atoms and figures, 3) "Cosmoplastick or Stoical", in which the universe is viewed as a great vegetable, a kind of spontaneously intelligent, but unconscious and impersonal Nature, and 4) "Hylozoick or Stratonical", which bestows energy, life, and perception upon matter itself. See [Yolt83] p. 5 and [Hutc83] p. 320. Cf. also [Tuve82] p. 67 et seqq. On the history of materialism, see also [Lang1907], [Yolt83], and [Spin60].

[1472] In [Corb72], Henry Corbin, discussing the worldview of some Neoplatonic Persian and Arabian mystics and theosophers, such as al-Suhrawardi, makes an interesting distinction between three different 'worlds', viz. the *mundus sensibilis,* which is the ordinary sensible world we interact with through our five senses, the *mundus intelligibilis,* which is the immaterial, non-spatial world of pure ideas reached through "intellectual intuition", and the *mundus imaginalis,* which, according to Corbin, is an intermediary space between the other two worlds with its own "immaterial" materiality, corporeality, and spatiality, being accessible through "spiritual imagination", a faculty or organ – associated with the "subtle body" or "body of resurrection" – that "makes possible a transmutation of inner spiritual states into outer states, into vision-events symbolizing with these inner states". The *mundus imaginalis,* albeit accessed through man's interior, encloses, as it were, the entire sensible world, to which it ranks as ontologically prior, whereas it is, in turn, inferior to the *mundus intelligibilis.* Also known as "the other world" and the "after world", it is populated by the spirits of the departed as well as various other angelic, spiritual, and demonic beings and it also holds the archetypal images of individual and singular things. In Corbin's view, the *imaginal* is a reality more real than the sensible, not to be mixed up with the *imaginary* or *utopian,* which rather is to be understood as a secularisation hereof, becoming prominent only when the contact with the *mundus imaginalis* had been more or less lost, or at least terribly disrupted. He concludes: "Unless we have access to a cosmology structured similarly to that of the traditional oriental philosophers, with a plurality of universes arranged in ascending order, our imagination will remain *out of focus,* and its recurrent conjunctions with our will to power will be a never-ending source of horrors." Corbin's "spiritual imagination" can perhaps be compared to such concepts and ideas as the "mindsight" discussed in [RC99], Hugh of St. Victor's and St. Bonaventure's "three eyes" of the rational soul, viz. the eye of flesh, the eye of reason, and the eye of contemplation, the 'ideoplastic' (reactive, quasi-intelligent) character of psi phenomena pointed out by [Hans01b] p. 216, and

inhabited by spirits, angels, demons, and lesser divinities, if such beings are assumed to exist – consists of a finer kind of matter than the visible variety, as was the view of virtually all 'materialists' until rather recently, including Democritus, the Epicureans, the Stoa, some early Christians (notably Tertullian), Hobbes, various other early modern thinkers, and a few more recent 'materialists', such as the Dutch scholar K. H. E. de Jong[1473]

3) *Gamma:* the view that all that exists is matter of different kinds except for one single entity, which is non-material or spiritual and may be referred to as God, the Ground, the Absolute, Nirvana, or suchlike; this view, it seems, is implied in Buddhist doctrine and has also been supported by some Christian thinkers, including Clemens Alexandrinus, Origen, and St. Bernard of Clairvaux, and, indeed, is advocated by Poortman himself

4) *Delta:* both non-material spirit and different kinds of matter exist, and human beings do not just consist of matter and a fine-material soul, but of spirit as well, as Plato and Aristotle probably held[1474] and as is one, albeit possibly not the correct, interpretation of the Pauline and early Christian view of man as made up of a (coarse-material) body, a (fine-material) soul, and (non-material) spirit – an interpretation supported by e.g. St. Augustine, St. Bonaventure, and many other theologians, in particular before the Scholastic adoption of Aristotelianism[1475]

"the God Spot" situated in the right temporal lobe of the brain and supposed to provide some kind of interface to the spiritual world according to the speculations put forth in works such as [Mors00a]. Cf. also [Corb93] p. 51 et seqq., [Chit94] p. 67 et seqq., [Watk90], [Wolf94a], [Hans01b] p. 395 et seqq., [Yate66], and [Godw91] p. 70.

1473 On the exact nature of this other kind of "fine matter", there is no general agreement. In old times, it could be identified with 'fine-grained' atoms, light, the fifth element (ether or *quinta essentia),* or *pneuma* (Greek for 'air' or 'spirit', *spiritus* in Latin). As for *pneuma,* [Poor78] part I, p. 19 et seqq. distinguishes four kinds of it: 1) *physical pneuma,* i.e. air, 2) *physiological pneuma,* the 'animal spirits' of ancient medical theory, i.e. the *spiritus naturales, vitales,* and *animales,* 3) *psychological pneuma,* the material of St. Paul's 'psychic body' and the Neoplatonic *ochema,* the 'ether' or 'astral' body, believed to provide an intermediary between mind and body 4) *subtle pneuma,* the material of St. Paul's 'pneumatic body' and the Neoplatonic *augoeides ochema,* the 'radiant' or 'subtle' body, a still finer body than the astral one, believed to be another intermediary between the man's spiritual essence and the ordinary body. See also [Kiss22], [Fina85], and [Proc63] p. 313 et seqq. On similar concepts in Indian philosophy, see also [Glas80] p. 231 et seqq.

Modern adherents of hylic pluralism may explain 'fine matter' in terms of a hypothetical new type of particles/waves, some kind of field or plasma, a fourth/fifth/nth dimension (see [Rand82], [Ruck84], and [Schn13] p. 557 et seqq.), or the like and may point to various, partly rather contentious phenomena (some of which are surveyed in [Brus99] p. 149 et seqq.), such as special kinds of fields supposed to be associated with living beings, e.g. the electro-dynamic fields (sometimes called 'life fields' or 'L-fields') explored by Burr, Becker, and others (see [Burr72], [BS87], [Beck91], and [Beck92]), the so-called Kirlian effect, which caused the Russian researcher W. M. Inyushin to suggest the existence of a 'bioplasma body', while others interpret the phenomenon as insignificant 'corona discharges' (see [KR74], [DL78], [Moss79], [Dumi83], [Whit88], and [Iovi94]), the 'aura' seen by some clairvoyants and, perhaps, with the help of so-called Kilner glasses or special training also by at least some people without exceptional psychic gifts (see [Kiln76] and [Bagn70]), the hypothetical substance of the 'astral body' perceived by some astral projectors during out-of-the-body experiences (see e.g. [Gree68] p. 30 et seqq.), etc. Cf. also [Beck93] p. 170 et seqq. and [Alva80]. At http://ourworld.compuserve.com/homepages/Paraphys, the scholarly journal *Yggdrasil. The Journal of Paraphysics,* devoted to the study of paranormal phenomena from the physicist's point of view, can be found together with links to web sites with a similar content (cf. also http://moebius.psy.ed.ac.uk/Physical_H.html). See also [Beic01], [Mizr], [EMRP86] p. 276 et seqq., [Hans01b] p. 331 et seqq., and [Oter75].

1474 Currently Plato is usually depicted as a radical mind-matter dualist and, thus, an adherent of the *Epsilon* standpoint, but, although the evidence from his writings is ambiguous (except perhaps for the passage *Lg. 898-899),* it seems likely, that he, as was generally assumed by the Neoplatonists, taught the existence of the *aitherion soma,* as this idea was in fact advocated by his pupils Speusippus and Heraclides Ponticus. See [Poor78] vol. II, p. 32 et seqq. Cf. also [Voge86] p. 159 et seqq.

1475 Like the Neoplatonists, St. Augustine, at least tentatively, espoused the doctrine of the *pluriformitas* of man. According to this view, man is a duplex being, consisting of the two independent substances of body and soul. As both of these, *qua* substances, consist of matter and form, man has two different forms, one of the body and another of the soul, of which the former is referred to as the *forma corporeitas*. Likewise, the soul is assumed to be of a special kind of matter, a *materia spiritualis*. Finally, the innermost part of man, the "spirit", may in this scheme be construed as a non-material substance, separate from the substances of both the soul and the body *(trichotomism).* These views were made more or less theologically impossible by the *dichotomist* verdict of the council of Vienne in 1312, at which the rational soul was declared to be the form of the body (see footnote 1918 on p. 409 below; cf. also footnote 2058 on p. 445). See [Poor78] vol. II p. 86 et seqq.

In the trichotomist scheme, the spirit, or some core part of it, may optionally be viewed as divine in origin or, alternatively, as a receptacle for the divine spirit, as has been suggested time and again by enthusiasts and heterodox mystics through the ages. Although this idea *prima facie* may seem to have some scriptural support in the *Genesis* account of God's spiration of his breath into man *(Gen. 2:7),* orthodox Christian (as well as Jewish and Moslem) theologians recoil at such claims, rejecting them as preposterous spiritual hubris, and would

5) *Epsilon:* radical mind-matter dualism[1476], as in Descartes' well-known division between *res cogitans* and *res extensa* and as, perhaps, also implicitly in Aquinas' teachings on the soul as the *non-material* form of the body[1477], often presumed to be the "common sense view" held by "the man in the street"[1478] and also advocated by many parapsychologists, who construe psychokinesis and ESP as the links between mind and matter, i.e. the mechanisms by which the mind controls the neurones of the brain and is, in turn, affected by them[1479]

rather construe the *Genesis* passage as simply saying that God bestows upon man the vital principle that calls him into life. By the same token, the obscure comments in Aristotle's *De Anima III.v* on the adventitiousness of the *nous poietikos (intellectus agens)* gave rise to much pantheist speculation, inspiring the medieval controversies over Aristotelian and Averroist monopsychism (or, more correctly, mono-noism); on this topic, see [Merl63] and [Davi92a]. On the universal presence of the story of man's creation from a clay figure, in which divine breath was inspirited, see [Pett57] p. 18 et seqq.

1476 [Tali94b] p. 26 et seqq. distinguishes three forms of dualism, *interactionist dualism,* according to which mind and matter somehow interact causally, probably primarily through a brain, *occasionalist dualism,* according to which no such direct causal interaction is possible, but God has to co-ordinate or pre-stabilise a harmony between the mental and the physical, and *epiphenomenalist dualism,* according to which matter affects and determines the mental, but not vice versa. The last view is, in our contention, better regarded as a variant of materialism.

In [Duca74] p. 82 et seq., C. J. Ducasse introduces the useful term "hypophenomenalism", making a distinction between *cosmological* and *biological hypophenomenalism.* Whereas the proponents of the former contend that "not only the living body, but also all other material objects are hypophenomena of minds, i.e., are products or objectifications of psychical activity or, as Schopenhauer had it, of Will", those advocating the latter restrict the dominion of mind to living beings. In his discussion of the mind-body problem (id. op p. 63 et seqq.), Ducasse, who like most modern philosophers neglects hylic pluralism (cf. however id op. p. 97), discerns the following basic views regarding the relation of mind and matter: I) *materialism* ("mind conceived as bodily process", i.e. Poortman's *Alpha* standpoint), II) *idealism* ("matter conceived as sets of ideas"; Poortman's *Zeta* standpoint), III) various varieties of mind-body *dualism* (in essence, Poortman's *Delta* standpoint), including 1) psycho-physical *parallelism,* which denies the existence of a causal nexus between the *per se* self-sufficient substances mind and matter and may be either of i) the "pre-established harmony" variety as with Leibniz or of ii) the "double aspect" variety as with Spinoza, 2) views recognising a causal connection between brain activity and mental activity, of which three distinct types exist, viz. i) *epiphenomenalism,* which asserts that all mental activity is causally dependent upon brain activity, ii) *hypophenomenalism,* which, conversely, assumes that the brain activity is causally dependent upon mental activity, and iii) psycho-physical *interactionism,* according to which causal dependencies of both the brain-mind and the mind-brain type exist. Of these standpoints, he rejects all save *hypophenomenalism* and *interactionism,* the latter of which he tends to regard as a (superior) variant of the former. A more complex categorisation is suggested in [Jone99].

1477 There is, however, a very important difference between Descartes' and St. Thomas' dualism, insofar as the former philosopher made the soul disappear from space entirely, thereby paving the way for its radical elimination by monist materialists, such as de La Mettrie, whereas St. Thomas conceived of the soul as a *form* (or, a field, as would, perhaps, be a more up-to-date term), which, albeit immaterial – as dictated by the Aristotelian antithesis of form and matter –, had a definite location in space and, during its hylomorphic union with the body, also apparently extension. Perhaps, the Thomistic-Scholastic conception should have been accorded a category of its own between *Delta* and *Epsilon,* as indeed it has in the classification of [Wies57] p. 57 et seq. The Cambridge Platonists Henry More and Joseph Glanvill, having grown increasingly critical of Descartes' ideas and, in particular, of his *nullibism* or despatialisation of the soul, which they perceived might easily lead to corporealism (i.e. materialism) and atheism, as indeed indicated by Hobbes' philosophy, instead suggested the existence of a "fourth dimension" as the abode of the souls, using the intriguing alchemical term *essential spissitude* to designate it, construing it as the soul's capability for "the redoubling or contracting of Substance into less space than it does sometimes occupy" (quoted from [Patr69] p. 31.). Notably, they further characterised body as impenetrable, inert, and discerpible (divisible), spirit as penetrable, active, and indiscerpible. See [Glan78] p. 99 et seqq.

1478 [Edge00] argues that this is really only the common sense view of individualistic-atomistic Western culture.

1479 See, for example, [TW47]. By this reasoning, the most common forms of paranormal phenomena can be interpreted as a kind of "leakage" of the ordinary mind-brain interaction mechanism. John Beloff is probably the most well-known now living property dualist that underpins this stance with arguments derived from an intimate knowledge of parapsychology. See [Belo62], [Belo90], and the various essays by him available at http://moebius.psy.ed.ac.uk/~dualism/index.html. Interesting critiques of his ideas are to be found in [Bier96], [Bier98] (pointing out the apparently meta-causal, acausal, or retro-causal character of some paranormal phenomena, such as *precognition, retroactive psychokinesis,* and *synchronicity,* not easily explicable in a common-sense dualist framework; cf. also [Hans01b] p. 328 et seq.), [Rose94] p. 149 et seqq. and p. 179 et seqq. (taking into account the apparent paradoxicality of both psi phenomena and modern physics), and [Edge00] (emphasising the cross-cultural variety of "folk metaphysics"). Likewise, in line with the current climate of opinion the present generation of psychical researchers tends to be unsympathetic towards "Cartesian" dualism: Many instead advocate some kind of holistic ("holographic", "holonomic", "integrative", etc.), more or less explicitly mystical-pantheistic connectionism based on a personal blend of ideas from quantum physics, Eastern philosophy, transpersonal psychology, process philosophy, and the Western occult-Platonic tradition, whereas others look for some more conventional physicalist explanation of the paranormal phenomena. Obviously, there are trends also in metaphysics – for example, [Cari49] even tried to explain the paranormal in terms of the at the time very popular philosophical theory of *neutral monism* (often also referred to as *empiriocriticism* or *phenomenalism),* i.e. the essentially naturalistic-positivistic doctrine – embraced in one form or other by, for example, Avenarius, Mach, Gomperz, Carnap, Russell, and Ayer – that both material and mental phenomena can be ultimately reduced to sense data, which, according to this theory, are to be equated with the pre-eminently real.

6) *Zeta:* monist idealism or illusionism (acosmism), as in the Vedic ideas about reality as the veil of Maya, which, as a matter of fact, may come very close to the *Gamma* or the *Delta* points of view, if matter is seen as some kind of basically illusory emanation of God, the 'matter of thought' of God, or the like.

There are of course many important dimensions of a *Weltanschauung* besides the topic of mind vs. matter, such as the complexes of ideas pertaining to:

1) necessity vs. freedom (determinism vs. free will)
2) the nature, structure, and status
   i) of God (theism, pantheism, panentheism, henotheism, kathenotheism, polytheism, deism, atheism, etc., God's degree of personality, goodness, omnipotence, etc. or lack thereof)
   ii) of man
   iii) of the members of the animal and plant kingdoms
   iv) of other spiritual beings (lesser gods, spirits, angels, demons, etc, i.e. the inhabitants of Corbin's *mundus imaginalis),* if such beings are believed to exist
3) the condition of the human soul after death
4) ethics, good and evil, virtues and vices, sin, and the proper organisation of society, family, and the inner and spiritual life of man
5) the general attitude towards the world, other people, and other beings
6) the organisation of cosmos and its various inhabitants
7) nature, cosmogony, history, science, etc. ad infinitum

Still, Poortman's scheme implicitly tends to subsume at least some of these additional dimensions as well. For example, the *Alpha, Beta,* and *Gamma* standpoints will generally imply some kind of determinism, whereas the *Delta* and *Epsilon* views will lend support to the notion of man's free will. The notion of *theism,* at least if God is believed to possess a personality, seems to sort best with the *Delta* and *Epsilon* standpoints, although it may be reconciled also with the standpoints *Beta, Gamma,* and *Zeta.* Pantheism more or less presupposes the *Zeta* standpoint, whereas panentheism will be a hybrid of the *Zeta* and *Delta* (or *Gamma)* standpoints. Atheism will be possible only within an *Alpha* or *Beta* frame of reference.[1480] Whereas the belief in a life after death clearly clashes with the *Alpha* standpoint, it seems possible to combine such an idea with all the other standpoints, although if it is taken to imply that there is some stable part of human personality that not only

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While most of the literature on parapsychology has rather obvious bearings on philosophy, some works more specifically concerned with the relationship between parapsychology and philosophy are [Jame61b], [Gump24], [Broa62], [Broa69], [Marc56], [Ring59], [McCr72], [Brie74], [Brau78], [Brau86], [Nich00], [Grif97], [Fren75], [Thak76], [WE76], [SC77], [Ludw78], [SC79], [Grim82], [Flew87], [SC87], [SC89], [Stok97], and [Tart97]. Although 20th century philosophy was characterised by the "revolt against dualism" noted by [Love60], there have been some distinguished advocates of interactionist dualism, including the brain scientists John Eccles (see [PE81] and [ER84]), Wilder Penfield (see [Penf75]), and John Smythies, whose "dualism" may perhaps, however, be better characterised as a kind of hylic pluralism of the *Beta* variety (see [Smyt94], [Smyt88], and [Smyt00]), the physicist Henry Margenau (see [Marg84]), and the philosophers Karl Popper (see [PE81]), C. J. Ducasse (see [Duca51] and [Duca74]), W. D. Hart (see [Hart88]), John Foster (see [Fost91]) and, albeit in a rather diluted form, C.D. Broad (see [Broa29], [Broa62], and [Broa69) as well as a number of Christian philosophers, such as H. D. Lewis (see [Lewi69b] and [Lewi78]), Richard Swinburne (see [Swin86]), Charles Taliaferro (see [Tali94b] and [Tali00]), and, of course, the Catholic neo-Thomists. See also [Smyt65], [VE81], [SB89], and [CM00].

[1480] Some Indian religions, sects, and philosophical schools, most notably *Buddhism* and *Jainism,* are often referred to as "atheistic". Generally, this does not imply that they deny the existence of divine beings, a moral world order, or even a creator God or an absolute ground behind the phenomena of the visible world. Rather, these schools are "atheistic" in the sense *non-theistic (nir-ishvara),* which is to say that they deny that the world is *ultimately* the result of the activity of an eternal, personal, world-ruling God, an *ishvara.* Rather, if they acknowledge the existence of a more or less personal creator God, a Brahman, as is usually done in Buddhism, at least in principle, he is himself regarded as somehow emanating from the impersonal and to man wholly inconceivable world-ground, which, thus, in fact comes quite close to *The One* in the Western (and Islamic) tradition of Neoplatonic mysticism and not too far from the *hypostasis* of the Father in the Christian Holy Trinity. See [Glas80] p. 229 et seq. At most, this "atheism" may come close to Cudworth's "cosmo-plastick atheism" (see footnote 1471 on p. 296 above), but is perhaps better characterised as a kind of impersonal pantheism.

survives death, but is immortal and remains separate and active in the post-mortem state, then the *Delta* and *Epsilon* standpoints, which support the idea of spiritual monads, seem most appropriate.

Although taken as *ideal types,* Poortman's, Dilthey's, and others' attempts[1481] at terminological clarification will certainly be both useful and laudatory, one may blame these and kindred schemes for over-simplification, in particular with reference to the complex intertwinement of the religious, metaphysical, and various other dimensions in our worldviews, or for leaving out, for example, such an important stance as that of scepticism, i.e. the systematic suspension of judgement in metaphysical matters. Additionally, the categorisations discussed have a distinctly philosophical slant, which may be less appropriate when dealing with worldviews of a non-philosophical nature, such as those of the common man in the street or of illiterate or 'primitive' societies.[1482] An overly abstract and generalising typological approach may also obscure the integrity of the individual worldviews by focusing on a few rather general aspects rather than on the intricate web of interrelations that together make up the integral whole of a specific belief-system.

3.1.1 BEYOND WORLDVIEWS

> *For where your treasure is, there will your heart be also.*
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> *Ev. Luc. 12:34*

If metaphysical standpoints and worldviews may appear bloodless and abstract theoretical constructs, at least when contemplated in the form of typological stereotypes, one will be entitled to ask what the sap is that lends life to such ethereal phantoms. Arguably, to come to terms with this question we will need some kind of 'meta-metaphysics' concerned with the hidden agendas and ulterior mainsprings that can be perceived as a kind of surrounding nimbus of each worldview. In fact, there is no want for suggestions about where these mainsprings are to be sought – in psychological or ethnical dispositions, in all kinds of environmental factors of the "life-world", in which a certain worldview has arisen, in the social dynamics of various "communities of belief"[1483], in the economical base, of which Marxians believed worldviews to be the superstructures, etc. Although these explanations cannot be dismissed lightly and certainly all contain some nugget of truth, they still do not, I contend, penetrate into the real nucleus of the matter, which is to be searched for elsewhere. Later, I will come back to the delicate puzzle of where to locate this "elsewhere", but first we will need to take a look at a selection of the suggestions made by others on this issue.

Firstly, it should be noted that, besides Dilthey's and Poortman's primarily philosophically oriented criteria for the classification of worldviews, various other more or less influential attempts to compartmentalise the chief human attitudes to existence on the basis of somewhat less intellectualistic assumptions have been made.[1484] For example, Arthur Lovejoy in *The Great Chain of Being* made a distinction between the two

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1481 Various typologies other than the ones described above of course also exist. For example, the influential French 19th-century philosopher Victor Cousin, the founder of the so-called "spiritualistic school" of philosophy, believed that human thought could be summed up in the four great systems *sensism, idealism, scepticism,* and *mysticism,* which he himself attempted to combine eclectically (see [Sauv1909]). In [Pepp70], Stephen Pepper contends that there are in all 7-8 "world hypotheses" based on certain "root metaphors". Of these world hypotheses, he gives *animism* (apparently Pepper's smear word for religion) and *mysticism* short shrift, whereas he treats of *formism* (Platonic-Aristotelian idealism), *mechanism* (materialism/naturalism), *contextualism* (pragmatism), and *organicism* (the "absolute idealism" of the Schelling-Hegel tradition) at some length. In [Wilb02], the New Age philosopher Ken Wilber discusses various typologies of worldviews and suggests his own – very complex – one, based on his "holonic model" of "the four quadrants" (cf. also [Wilb98] p. 63 et seqq. for a discussion of this model). Although he makes some good points here, especially by taking into account both the worldview theorist's own spiritual starting-point or "level of self" and the domain or "level of reality" targeted by his theory, the somewhat flimsy recourse to such concepts as "chakras" or "memes" (of different colours!) and the proclivity for overwrought schematism will be less commendable.

1482 See e.g. [Radi57a] and [Lévi70].

1483 See [Brig89]. [Coll98c] is a fascinating tour-de-force in the "sociology of philosophy", authored by one of the leading explorers of this new realm of research.

1484 We cannot and will not discuss here such pedestrian, but useful and telling characterisations as those implied by the conceptual antinomies pessimist-optimist, religious-irreligious, dogmatic-freethinking, right-left, conservative-liberal-socialist, moralist-libertine, intellectual-practical, and innumerable similar notions being part and parcel of our everyday language.

fundamental attitudes of *otherworldliness* and *this-worldliness,*[1485] whereas C. S. Peirce in an essay entitled *Evolutionary Love*[1486] distinguished three basically different ways of understanding the cosmos, viz. as operated by love *(agapism),* by chance *(tychism),* or by mechanical necessity *(anancism).* In this context, it will also be appropriate to mention Oswald Spengler's well-known characterisation in *Der Untergang des Abendlandes* of our culture as "Faustian" (prone to transgress all boundaries), ancient culture as "Apollonian" (dominated by the ideas of harmony and balance and by an ingrained aversion to extremes), and Near East and Islamic culture as "Magian" (subject to a feeling of an absolute dependency on the divine, the powers, the stars, and the like).[1487] By the same token, the famous Russian-American sociologist Pitirim Sorokin traced the historical fluctuations between what he called *ideational, idealistic,* and *sensate* attitudes (simply put, attitudes ranging from idealistic otherworldliness to materialistic thisworldliness) in art, music, literature, ethics, law, social life, etc. through the ages; a somewhat similar attempt to track down such historical dynamics in philosophy proper was made by the Austrian philosopher Karl Joël.[1488] Doubtless, such categorisations, based on the general sentiment implicit in an outlook and, in particular, on its emotive colouring, have a place besides Dilthey's and Poortman's more intellectualist approaches.

As mentioned above, there have also been various attempts to look at worldviews from a psychological, sociological, or historical point of view. For instance, William James, the American pragmatist philosopher and psychologist, made a distinction between a *tenderminded* and *toughminded* mindset, characterising the former as *rationalistic* (going by 'principles'), *intellectualistic, idealistic, optimistic, religious, free-willist, monistic,* and *dogmatical,* the latter as *empiricist* (going by 'facts'), *sensationalistic, materialistic, pessimistic, irreligious, fatalistic, pluralistic,* and *sceptical.*[1489] Somewhat similarly, the German philosopher Eucken used the term *syntagma* to characterise such fundamental attitudes to life as aestheticism, intellectualism, or naturalism.[1490] James' and Eucken's schemes may appear somewhat over-simplified, and, indeed, in the early 19th century various German philosophers tried to work out a much more complex and sophisticated psychology of worldviews, combining the idea of types of worldviews with the idea of types of personality.[1491] The most famous of these will be the one put together by the German existentialist philosopher Karl Jaspers, whose perceptive and erudite, but quite complex, theories also well illustrate the difficulties and dangers inherent in the psychological approach and, in particular, its readiness to end up in subjectivity and self-justification. Without detracting from the great and indisputable merits and many subtle observations of Jaspers' study, I think it is fair to say that it says as much about the – post-Nietzschean, nihilistic – philosophical climate of opinion in German academic circles in the early 20th century and about what Karl Jaspers believed or would like us to believe as regards why he himself espoused the worldview he did, as it says about the psychological factors actually involved in the espousal of a worldview in the general case.[1492] Nevertheless, the rationale behind Karl Jaspers' worldview is of course an

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1485 [Love64] p. 24 et seqq. It goes without saying that there is a wide spectrum of attitudes between the extremes of dyed-in-the-wool otherworldly asceticism and unbridled this-worldly hedonism.

1486 See [Peir55] p. 364. Cf. also [Barb97] p. 204 et seqq.

1487 [Spen97]

1488 See [Soro37] and [Joël28]. Cf. also [Brow96b], [Aspe68], [Sche63] p. 13 et seqq., [Gils99] p. 241 et seqq., and [Hawk97] p. 21, who makes an interesting distinction between *world view* and *ideology,* defining the former as consisting of assumptions about the order of nature and man' s rôle in it and the latter as a theory of human interactions and institutions that also comprises critical and prescriptive ideas on the proper organisation of society.

1489 See [Jame75] p. 13. Interestingly, [West84b] p. 212 et seqq., following [Holt73] p. 115 et seqq., argues that Niels Bohr, who was an avid reader of James' writings, was influenced by James when he formed his notion of complementarity. He also suggests the Jung's distinction between the *extravert* and *introvert* personality types and his pre-occupation with overcoming and assimilating opposites owe something to James' ideas.

1490 Like Dilthey and Spranger, Eucken was a leading exponent of the so-called *Lebensphilosophie,* which played a prominent rôle in German philosophy around 1900.

1491 [Hlu□29] surveys most of these. Notably, Eduard Spranger's influential work *Lebensformen* [Spre25] suggested six ideal types of individuality, "der theoretische Mensch", "der ökonomische Mensch", "der ästhetische Mensch", "der soziale Mensch", "der Machtmensch", and "der religiöse Mensch". See also [Adic1905], [Müll23], and [Høff25].

1492 See [Jasp94]. The tendency of the psychologising-developmental schemes to end up in rather awkward forms of self-approbation, countenancing what are but the theorists' prejudices, personal opinions, and preferred life-style as the highest stage of moral development, cannot but strike one's eyes in some of the more recent theories surveyed in [Wilb02] and [Webb97b]. This modern self-righteousness, which obviously feeds on the modernist rejection of the Christian insight into man's finitude and congenital depravation, guilt, and sinfulness, contrasts starkly with the Christian ideal of sanctification as the pilgrim's arduous progress towards the goal of sainthood and martyrdom, tempered by the realisation that only very few will, and then by God's grace rather than by their own merit, be

interesting topic of its own, as Jaspers was one of the leading philosophical minds of his time, and he also makes many noteworthy points in his book, which, for one thing, is known to have made an important impact on Eric Voegelin, whose ideas we will come back to frequently in the present essay. Interesting is certainly Jaspers' notion of *Grenzsituationen,* such as death, struggle, guilt, and chance happenings, through which our metaphysical commitments are brought to a head and, as it were, tested out. Likewise, his analysis of different outlooks, *Einstellungen,* albeit somewhat encumbered by the sere schematism of the typological approach, contains many fine observations.

Jaspers was, in turn, much inspired by Kierkegaard, who in his theory of "stadier paa livets vei" ("stages on life's way") distinguished between five such stages or forms of existence, to wit[1493]

1) *the aesthetical stage:* living as a child for and in "the moment" governed by "immediacy", just letting things happen, guarding one's own interests, refusing to take any responsibility for one's life, and instead trying to get as much enjoyment and profit as possible from it – for example by a "carpe diem" mentality or by leading the life of the philistine, the refined hedonist aesthete, the scientist pleasing himself with the pursuit of his research, or the intellectualist seducer, who seeks pleasure in philosophical speculation, gnostic insights, or poetic fiction (typified by Hegel)
2) *irony:* seeing the hollowness of the aesthetical stage and ironising over it, but refusing to acknowledge ethics as the solution to it
3) *the ethical stage:* living responsibly, guided by a commitment to an ethical principle of enduring validity, feeling guilt and remorse when one fails (typified by Socrates)
4) *humour:* having realised that man cannot by his own remorse reconcile life and ideal and, to achieve this, some kind of divine transcendence is needed, but not daring to believe in the possibility of such a divine incursion and instead vainly, and thus tragically, trying to bring about reconciliation for oneself and others through humour
5) *the religious stage:* embracing the Christian faith, as one has recognised as *sin* the guilt that cannot be mitigated by man's own strivings or washed off by his own contrition and as one has come to realise that the outcome and bottom line of all the other stages is despair, *fortvivlan,* and that this despair can only be relieved by God, who, by forgiving the repentant sinner that takes refuge with Him through faith, restores man, gives meaning to his life, and, paradoxically having entered into time and history Himself as the Godman Jesus Christ, offers to man the possibility of becoming like God by leading a life in imitation of Christ (who, thus, also typifies this kind of existence)

The transition from the aesthetical to the ethical stage as well as from the ethical to the religious stage takes place by a "leap" or existential choice, but whereas in the former case this transition is a possibility that man possesses in principle, the latter one is an act or leap of faith, which only can be brought about by God's grace, as man through his sinfulness has destroyed his own autonomy and the proper relationship to the eternal God. By secularising and psychologising Kierkegaard's Christian transcendentalism and locating themselves securely at the lower end of his scale of stages, Jaspers and many other of his existentialist colleagues in fact hideously trivialised the great, but abrasive Dane's thought and made to nought the very point of it, replacing his unflinching devotion to Christ with their own bland pseudo-religion of self-complacent nihilistic authenticity – in fact just the kind of philosophical speculation Kierkegaard so vehemently abhorred. Nonetheless, it must be admitted that Kierkegaard, by his stage theory elaborating on the age-old Christian theme of sanctification and our earthly life as a pilgrimage expounded in innumerable works of pious edification, himself seems to reflect the decline of Christian faith in the Protestant world, insofar as he makes what was only the starting-point of these earlier guidelines for the pilgrim's progress – to wit the *conversion* to the Christian faith –, the crowning achievement.

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able to come close to such a goal and that the struggle to attain it will always imply a large amount of self-oblivion, sacrifice, and suffering and be accompanied by all kinds of spiritual pitfalls and perils, which, additionally, tend to aggravate the nearer the prospective saint draws to the end of his pious aspirations.

1493 See [Kier63a] (cf. also [Kier65] and [Kier63b]). See also [Lübc88] p. 291 et seqq., [Höff95] part II p. 335 et seqq., and [Luba71] p. 50 et seqq.

One may also relate Kierkegaard's classification to the New Testament and in particular St. Paul's epistles, where the apostle's antithesis of Mosaic Law and Christian freedom corresponds neatly to Kierkegaard's antithesis of the ethical and the religious stages. Furthermore, the term *ψυχικὸς ἄνθρωπος*, a "natural man" (or "soulish man"), used by St. Paul and other New Testament epistlers to designate a person with no understanding of spiritual things – such as a mocker or a trouble-maker, whose heart is filled with envy and strife – in contradistinction to a *πνευματικὸς ἄνθρωπος*, a "spiritual man", who has the mind of Christ, seems to provide us with the Biblical archetype for the aesthetical man.[1494] As pointed out by Eric Voegelin in one of his essays, in Plato as well as in the Old Testament "fool" (i.e. *ἀμαθής* in Plato and *nabal* in Scripture) is the *terminus technicus* for a person, who is not open in his relation to divinity or pathologically shuts himself off from the spiritual realm altogether.[1495] Such "spiritual dullness", "contracted existence", or "deformation of the "heart"" (in Voegelin's words) typically becomes manifest through "godless" or "foolish" patterns of behaviour. That such spiritual blindness is God's punishment for man's moral decrepitude, the fundamental error of taking "pleasure in unrighteousness", is a view taken in some crucial Biblical passages.[1496] Scheler contended that the religious act is by necessity accomplished by all men ("eine Wesensnotwendige Mitgift der menschlichen geistigen Seele"), but when its object is not the adequate one, that is to say God, idolatry will be the result. Consequently, man worships either God or, failing to complete the religious act correctly, an idol, and the smashing of the idols ("Zerschmetterung der Götzen") becomes the first step towards spiritual recovery.[1497] Also Plato's dialogues are in fact largely concerned with the exposure of the inanity of such foolish attitudes. The typological path was trodden also by Plato's great pupil Aristotle with his doctrine of the three types of life (the apolaustic, the political, and the theoretical), which, despite its superficial similarity to Kierkegaard's scheme, characteristically obfuscates the significance of the spiritual component so important in Plato's and the Biblical characterologies.[1498]

Some decades before Kierkegaard, Fichte (in his aforementioned *Versuch)* portrayed the choice between *dogmatism* and *idealism* as not strictly rational, but rooted in character:

> *Was für eine Philosophie man wähle, hängt sonach davon ab, was man für ein Mensch ist: denn ein philosophisches System ist nicht ein todter Hausrath, den man ablegen oder annehmen könnte, wie es uns beliebte, sondern es ist beseelt durch die Seele des Menschen, der es hat. Ein von Natur schlaffer oder durch GeistesKnechtschaft, gelehrten Luxus, und Eitelkeit erschlaffter, und gekrümmter Charakter wird sich nie zum Idealismus erheben.*

Much in the same vein as Plato, Fichte, thus, regarded dogmatism/naturalism as a lower, unreflective, somewhat vulgar viewpoint, which stemmed from a kind of moral fallacy, incapability, or lack of development and illumination, showing its impotency by, *inter alia,* its inability to explain consciousness, freedom, and morality and to understand idealism, whereas idealism from its more elevated point of view could both explain these phenomena and understand dogmatism as conditioned by human finitude, frailty, and error. This line of reasoning, of course, partly rests on rather unabashed *ad hominem* arguments, which, however, are justified by Fichte's (and Plato's and the Biblical-Christian) premises, provided, of course, that one accepts them.[1499]

1494 See *1 Ep. Cor. 2:14*. Cf. also *Ep. Jac. 3:15,* and *Ep. Jud. 19.*

1495 See [Voeg85] p. 575 et seqq. (cf. also [Voeg78]) See also [Voeg87] p. 184 et seqq. for a dissection of the psychopathology of the disoriented "modern" man ridden by his passions and self-conceit, *amor sui,* rather than lead by the *amor Dei* of the Christian and classical transcendental orientation. According to [Clou91] p. 291 note 13, the foolishness of the atheist lies therein that he deceives himself into believing that he has no god, although he in fact is not an atheist at all, but an idolater.

1496 See, for example, *Ev. Jo. 3:19, 2 Ep. Thess. 2:11-12,* and *Ez. 14:3.*

1497 See also [Sche33] p. 559 et seqq.

1498 In the *Nicomachean Ethics I.v.*

1499 So [Sube90]. Cf. also [Peir55] p. 321 et seq. To rightly appreciate the deepest views and insights of Plato and Fichte and other philosophers of their mindset, it will be proper not to focus only on the level of philosophical ratiocination and their interactions with other philosophers, but to take into account also their relationship with religion and the spiritual traditions of their times as well as the possible experiential backdrop of their views in, for instance, contemplative practices and mystical experiences, as implied by, for example, their ideas on mystical "intellectual intuition". For one thing, the rather evident spiritual dimensions of early Greek philosophy have been

That there is a correlation between a lack of insight and morality on the one hand and materialism and atheism on the other has been recognised as more or less self-evident throughout history and has been seriously questioned only rather lately (by and large since the early Enlightenment or, to be more specific, since the appearance of Pierre Bayle's *Dictionnaire historique et critique* and Shaftesbury's and the British moralists' subsequent introduction of the notion of a *moral sense,* independent of one's religious conviction) and primarily by various thinkers, who themselves embrace materialist, libertinist, atheist, nihilist, and kindred ideas.[1500] From the point of view of the latter, the standpoints of idealists, mystics, or religionists like Plato, St.

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almost entirely obscured in the 20th-century philosophical and philological discourse (see [King95a] and [King99]) dominated by spiritual moles and angry religion-haters. In Plato's case, we need only point to the famous statement in 7th epistle 341C (quoted from Burnet's edition [Plat1900]): "*οὔκουν □μόν γε περ□ αὐτῶν □στιν σύγγραμμα οὐδὲ μήποτε γ□νηται· ῥητὸν γὰρ οὐδαμῶς □στ□ν ὡς ἄλλα μαθήματα, ἀλλ' □κ πολλῆς συνουσ□ας γιγνομ□νης περ□ τὸ πρᾶγμα αὐτὸ κα□ τοῦ συζῆν □ξα□φνης, ο□ον ἀπὸ πυρὸς πηδήσαντος □ξαφθὲν φῶς, □ν τῇ ψυχῇ γενόμενον αὐτὸ □αυτὸ ἤδη τρ□φει.*" The decisive impact of the long tradition of German mysticism, (Christian) Kabbalah, Hermeticism, and (neo-)Platonism, to say nothing of various mystics such as Meister Eckhart, Jacob Behmen, Swedenborg, Oetinger, Saint-Martin, etc. on German philosophy from Leibniz to the Romantics and indeed on many later and contemporary thinkers as well, as, for instance, Heidegger or Scheler, is regularly overlooked or glossed over in modern accounts of the history of philosophy. See [Benz83a], [Joël26], [Viat28], [Week93], [Faiv96], [Slad93], [Vond92], [Wals83], [Coud99], [NZ99], [Benz47], [Flor92], [Horn97], and [Voeg97] p. 3 et seqq.

1500 See, for example, [Hunt90] p. 442 et seqq. Cf. also [Naka92] p. 142 et seqq. and [Glas80] p. 83 et seqq. on this connection in ancient Indian and Chinese materialism. If we accept the general validity of the observation, as the present author indeed does, there are various provisos that must be made about it. Firstly, the worldview or faith a person professes – or pays "lip-service" to – may, as has been recognised since the dawn of time, not be the one that actually and always controls his being and acts. Although the phenomena of hypocrisy and "practical atheism" will perhaps be more eye-catching in a traditionally religious society, where the observance of certain religious scruples will be the rule, they are unquestionably still going strong also in our secularised, pluralistic modernity – though the standards by which one is judged have been significantly altered and are rather defined by the mass media than by religion (see [Gay98] on present-day "practical atheism" and [Blam97] on "the mental secularization of Christians"). Secondly, the division line between "materialism" and "religion", once upon a time perhaps reasonably clear-cut, at least in the Christian world, has become increasingly blurred by modern pluralism and various kinds of hybrid phenomena, such as liberal theology or New Age science. Thirdly, one and the same person may for a number of reasons that can be summed up under the heading of "human frailty" – including, for example, changing moods and opinions, lack of self-control or spiritual stamina and maturity, submissiveness in the face of external pressure and propaganda, conveniency, self-deceit, psychological insufficiency, etc. – shift between principally incompatible outlooks without necessarily being intentionally or even consciously dishonest or cynical. Fourthly, there is the category so relished by Bayle of the "religious atheist" or "atheist saint", who, naturally disposed towards virtue and kindliness and/or educated in a virtue-inspiring way, may live virtuously, as though the religious realm he denies actually existed, and outdo many a pious, but intermittently lapsing believer by his apparent goodness and integrity. Indeed, Christ's scathing reproof of hypocrisy and Pharisaism and his insistence on candour and purity of heart have put a strong stigma in our culture on all kinds of insincerity, and certainly many atheists and agnostics would have no difficulty persuading both themselves and others that their standpoint is the outcome of intellectual honesty.

For all these qualifications and the "ethical theism" of all the noble atheists, agnostics, and pagans as well as the appalling and much harped-on misdeeds imputed to various men of an – at least outwardly – religious conviction or even committed *in the name of* religion, no sensible man can doubt that the unrivalled horrors brought about by the secular ideologies of the 20th century (see e.g. [Conq86], [Conq90], [Conq01], [Hägg82], [Walk], [CWPP99], and R. J. Rummel's writings on modern genocide) as well as the rampant criminality, the ethical chaos, and the moral relativism of "modern times" are, as has been convincingly argued by, for example, Paul Johnson (see [John87] and [John85]), the corollaries of the decline of religion and the rise of secularism, terrifyingly proving the truth of Macaulay's observation, "Withdraw religion, and you will shake the pillars of society."

It seems possible to argue that all men in their hearts recognise that there indeed is a God, that is to say that this insight is both self-evident to and innate in man – or even, as would be the Christian viewpoint, constitutive of human existence, insofar as the most salient trait and very essence and point of the human way of being is its fundamental directedness and intentionality towards the divine. This granted, there would properly speaking be no such thing as "atheism", except as oblivion, wrong-headed or derailed ratiocination, some kind of escapism, perhaps from a sense of guilt, or a pretext on which human frailty and self-deceit disguise some kind of idolatry, if we take idolatry to mean the replacement of God, the proper object of this fundamental human intentionality, with some kind of surrogate object, be it through an act of rebellious turn-away from God or just from some kind of expediency or weakness. That human reason is the shuttlecock and easy prey of desire has been perceived by many thinkers, although they have always bickered about where to find the true wellspring of human irrationality, its deepest motive and mainspring – to Schopenhauer it was simply the will, to Nietzsche the will to power, to Freud man's lowest appetites, to Becker the fear of death, whereas to René Girard the fear of being found deficient in being, the dread of one's own nothingness, persistently makes man desire what he sees others desire.

Something of the extent to which men's wishes, desires, needs, beliefs, ideas, and expectations may surreptitiously and subtly influence their life worlds can be gathered by the study of the sheep/goat and experimenter effects noted by some psychical researchers, such as [SM64], [Schm72], [KT76], [Whit76b-c], [Whit77], [Palm77], and [Carp77]. The former effect implies that so-called *sheep* – i.e. subjects with a positive or open attitude to the paranormal – tend to score significantly better in ESP experiments than the *goats* sceptical or negative towards psi – the latter will even, it appears, occasionally be apt to score a significantly lower number of hits than can be explained by pure chance. Notably, there are also indications that strong believers in the paranormal may not be the best ESP subjects, but rather those with an open, uncommitted attitude towards it. Even more intriguingly, the "experimenter effect" haunts the ranks of the parapsychological researchers themselves, of whom some, it transpires, tend to produce consistently excellent results in their experiments, whereas others almost as consistently fail to find support for psi effects. Seemingly, some experimenters act as "psi catalysts", somehow being able to create a kind of psi-conducive rapport with their subjects that encourages these to produce significant results, whereas others – typical-

Paul, Fichte, Kierkegaard, and Voegelin, who held the naturalist worldview to be pathological and rooted in sin and confusion, are of course likely to be denounced as ridiculous, backwards, unenlightened, superstitious, or the like.[1501] Whatever one may think in these matters, it seems undeniable that in a modern pluralistic world, where one's worldview is *de facto* largely a matter of individual choice, personal preferences and, in particular, preferences appertaining to morality and ethics will very often decisively tinge and condition one's choice, as can also be perceived by the strong emotions and the lack of rationality often coming forth in discussions on worldviews and topics which have a bearing on one's choice of worldview. For one thing, there is an unmistakable streak of rebellion, not to say odium, against the traditional Christian culture and morality pervading most kinds of modern Western materialism, humanism, and atheism all since the Enlightenment[1502], apparently confirming Jacobi's age-old perception that, at least in the modern world, the fundamental division line is to be drawn between *naturalists* and *theists*.

This antithesis naturally leads on to another question, viz. that of the purportedly agonistic character of Western (and, in particular, Greek) thought, i.e. its proclivity for seeing things and views as starkly opposed to each other, although the notion that this agonistic penchant is an exclusive characteristic of Western philosophy and theology in contradistinction to, for example, the tolerant and magnanimous perspectivism of, say, Indian or Chinese thought, obviously is mistaken or at least in need of considerable qualification, as can be seen from any book on the philosophy or religion of these cultures. Be that as it may – speaking of

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ly those of an excessively sceptical mindset, but also some who claim to be supporters of the paranormal, for example on philosophical-religious grounds – act as "psi inhibitors", apparently being able to so disconcert their subjects as to make them unable to exercise any psi capabilities they may have. In addition, it has often been noted that observers present at an experiment may influence the result. There is also evidence that people only loosely associated with a psi experiment – such as persons preparing the targets used in it or checking or analysing the results *after its completion,* without ever seeing the subjects (or, in some cases, even the experimenters) – may affect its outcome. The question, if, where, and when such influences stop, is by no means easy to answer – see, for example, [Grub80] on some very fabulous results of experiments in retroactive psychokinesis! Can for example, as seems to be the case, future readers of an article about an experiment impact its outcome? And are "communities of belief", i.e. groups of people that share a common conviction, to some extent capable of forming "real reality" in accordance with their own "consensus reality"? This disturbing issue is referred to as the "divergence problem" amongst parapsychologists; for a discussion of it, see [Schm75], [Schm77], [Schm78], [Hans01b] p. 336 et seqq. The well-known "placebo effect" is a closely related and no less thought-provoking phenomenon, showing that effects of this kind are not limited to psychical research (see, for example, [WTS85]; cf. also [Flan38], [Rose66], and [Shel98]). Cf. also [Coll85] p. 29 et seqq. and [McGi79].

In sum, all this seems to indicate that the interaction between psychological and sociological factors is a very subtle and complex one indeed and that the borderline between outer and inner reality may be much fuzzier than we usually take for granted. What men seem to affirm and espouse wholeheartedly, they apparently may doubt or dislike – or be made to doubt or dislike – with some other part of their being, possibly wholly unconsciously, and, conversely, they may angrily oppose something that they in their hearts understand is true and right, such as the existence of paranormal phenomena or God, provided they are so motivated, either by some ingrained inclination of their own or by some external impulse or cue. Additionally, the philosophical ramifications of the aforementioned effects will be at least as mind-boggling as those of quantum physics, with which they are occasionally assumed to have something to do, and are apparently apt to call into question the foundations of both experimental science and our commonsense view of causality. Clearly, the possible nexus between this kind of effects and such more or less contentious notions as the "spirit of the times", "climate of opinion", "national character", "group minds", and "the collective unconscious" needs consideration.

For an interesting discussion of the psychological and sociological factors conducive to atheism, such as general socialisation in today's anti-religious and anti-Christian climate of opinion, career-making considerations (notably in Academe), personal convenience, etc., see [Vitz85], who also strikingly reveals Freud's theory of the Oedipus complex as the guise for Freud's own and, indeed, all modernity's prime wish-fulfilment fantasy, which is not about killing and taking the place of one's father in order to marry one's mother – certainly a most repugnant scenario to most young men –, but about killing and taking the place of God, the fear of whom is the prime obstacle for the indulgence in the dark desires that arise from man's unconscious – or from "the demons of the air", as would be the more traditional designation for the source of these wayward impulses – in the form of lust for power, gold, girls, or some other temptation, sin, or idol.

[1501] It still seems that the ground for doing so is highly doubtful, insofar as in the kind of basically nihilist belief system advocated by these atheists it would hardly matter whether you and your views are more or less "enlightened" or more or less "superstitious", as such moral judgements cannot be rationally justified at all in a nihilist frame of reference, lacking the support of Kant's three postulates (God, human freedom, the immortality of the soul), or at least something like them. [Wals90] p. 17 et seqq. aptly notes that "in the failure of modern philosophy to provide an alternative to the foundational rôle of religion [sc. for morality], we can recognize both the clearest illumination of the collapse of modernity and one of its central constitutive causes". See also [MacI84] and [Himm95].

As I will seek to show below, the naturalists are in fact only able to maintain their three anti-postulates – no God, no freedom, no immortality of the soul – by irrationally discounting the strong evidence in favour of the three Kantian suppositions through the application of the most ruthless rhetorical magic, by which the world is by force made to conform to their own Procrustean predilections and prejudices. And even if we were to grant that the evidence on such metaphysical questions is inconclusive, which I for one do not, it certainly would still be more rational to be a theist than an atheist, as Pascal showed with his deceptively simplistic, but principally irrefragable wager argument.

[1502] See [Camu87].

worldviews, one might perhaps make a coarse distinction between a *dogmatomachic* (or *controversialist)* and an *irenic* approach, where the former tends to regard worldviews as fundamentally irreconcilable, whereas the latter attempts to bridge the differences syncretically or eclectically.[1503]

Alternatively, one may take advantage of the categorisation used by the scholars of religion, when they distinguish between *exclusivism, inclusivism,* and *pluralism.*[1504] Whereas the *exclusivist* regards his own standpoint as the exclusively correct one, an adherent of the *inclusivist* position claims that his own system of thought gives access to a fuller kind of truth than that of the others, but does not exclude other viewpoints altogether, granting to them (or some of them) a lower or limited kind of truth that is, as it were, included in or covered by his own more comprehensive perspective. The *pluralist* (or *indifferentist),* finally, recognises a plurality of more or less equivalent roads to truth, none of which is to be given pride of place. In the West, the Christian churches have always taken an *inclusivist* view on the Jewish religion and occasionally on other religions and pagan philosophy as well.[1505] Similarly, in Moslem theology the Christian and Jewish religions are usually regarded as grounded in divine revelations now superseded by Islam and the Koran. In the East, *Mahayana Buddhists* similarly often entertain an *inclusivist* attitude towards *Hinayana Buddhism*. A few religions and religious sects, such as Manichaeism and Bahai are more fundamentally syncretic-eclectic in their approach to other religions, but, on the whole, *exclusivism* has certainly been the predominant attitude of both orthodox Christianity and the various non-Christian religions towards other faiths, acting as a safeguard for the integrity of the truth believed to be enshrined in one's own faith against doctrinal contamination and bewilderment. Likewise, many adherents of modern *scientism* and *positivism* will nourish an *exclusivist* preference for science as the sole source of truth. A few modernist Christian theologians, such as John Hick, advocate religious *pluralism,* as will, at least in a certain sense, many perennialists, such as Guénon and Schuon, various supporters of *New Age*-style mysticism, such as Joseph Campbell, and some present-day adepts of Eastern religions. It should be noted that there is an odd paradox built into the pluralist stance, as it, by denying the validity of exclusivism, betrays itself as a form pluralist exclusivism!

[1503] Notably, the irenic Scanian philosopher Hans Larsson advocated a "principle of convergence", according to which the different views on many issues can be made to converge, if their advocates take the trouble of trying to understand the real import of their seemingly clashing standpoints as well as the underlying motives and intentions of their adversaries. See [Lars24] p. 211 et seqq. Cf. also [Aspe77] vol. II p. 324.

[1504] [Smit84a] p. 23 et seqq. presents a similar scheme of "explanatory models" as to the plurality of worldviews within philosophy (and sociology), distinguishing between

- *scepticism:* pluralism is a sign of the bankruptcy of philosophy
- *relativism:* no valid criteria for worldview assessment can be found, which can be construed
  - as intolerable and a reason for embracing *scepticism*
  - as saying something essential about the nature of reality, e.g. that i) no reality exists *(ontological nihilism),* ii) many realities exist iii) reality is unknowable or only knowable through non-rational means
- *anarchism:* the idea of *The Truth* is mistaken and a plurality of worldviews to choose between is to be encouraged
- *monism:* only one true world view exists, which can be identified either by i) rational analysis or ii) fideistically
- *perspectivism:*
  - *oriental perspectivism:* many perspectives exist, none of which is uniquely correct, although within a certain perspective/orientation only one position is correct (i.e. *relativism* between systems, *monism* inside systems)
  - *monistic-systemic perspectivism:* although currently all perspectives are imperfect, most of them grasp some part of the truth and it will not be impossible in principle to find or at least approach a truthful worldview

[1505] Some of the fathers, such as Justin Martyr, Clemens Alexandrinus, and Eusebius of Caesarea, held that the *Logos* had been operative amongst the heathen as well as amongst the Jews, bestowing on their religion and philosophy a considerable amount of wisdom and insight as a *praeparatio evangelica.* Whereas the Old Testament is the unique revelation to the Jews of the *logos asarkos* or *logos incarnandus,* i.e. the *logos* without the flesh, yet to be incarnated (as distinct from the *logos ensarkos* or *logos incarnatus* of Christ come in the flesh), the *logos spermatikos,* the seminal or spermatic *logos,* had been working also in the minds of the heathen as a *semen religionis,* a seed of religion, by means of which some primitive intuitions about God had been instilled in all men so as to pave the way for the gospel, although, because of man's fallen state, often becoming deplorably mixed up with idolatry and various other uncomely errors rather than giving rise to true religion. For example, when a Christian inclusivist finds that death is widely held amongst primitive – and not so primitive – peoples to be unnatural and ultimately caused by some kind of mistake or misdeed perpetrated in the *Urzeit* (see [Pett72] p. 67 et seqq.), he may herein see an insight implanted amongst the heathen by the *Logos*. As for the mentioned terms, see the entries in [Mull85]. Cf. also [Voge85].

In this context, it may also be appropriate to mention Eric Voegelin's important observation that different 'languages' or 'symbolisations' may express equivalent points of view in quite different ways.[1506] For example, a myth can, in the peculiar 'language' of just myth, in a *compact* way represent an idea or primary experience of reality, which, albeit in its essence still the same, is expressed with more clarity and explicit detail in the *differentiations* made possible by the use of philosophical, theological, or scientific language.[1507] The usefulness of the concept pair *compact-differentiated* can easily be seen in authors such as Plato, who shifts back and forth between compact mythical and differentiated discursive-philosophical language, or when considering the relationship between movements such as Gnosticism and Neoplatonism, which, at least in one possible interpretative approach, can in certain respects perhaps be said to express similar basic experiences of the cosmos in a compact mythic symbolisation and a differentiated philosophic form, respectively. It should be noted that a differentiation does not necessarily imply an improvement over the more compact way of expression – Plato, for one, tends to take advantage of myths to express his most profound thoughts. Voegelin also suggests that the appearance of new 'languages' or 'symbolisations' can be understood as "leaps in being", which often fundamentally alter the way we look at the world, although our basic nature will of course remain the same. Evidently, these concepts can also be used, for example, to relate ancient mythic themes to modern scientific ideas.[1508] Additionally, they can be used to undergird the view that, although there are indeed worldviews that are fundamentally and irreconcilably dissimilar, there may also be some that, albeit *prima facie* very different, still have a common ground in a similar "primary experience of the cosmos", even though they may have emerged in entirely different types of cultures and at different times in history. This, of course, also is of considerable interest if we want to work out a typology consisting of a small number of mutually exclusive worldviews.

More recently, Roy A. Clouser, building on the work of the Dutch Calvinist philosopher Herman Dooyeweerd, has suggested a scheme of three kinds of "religious belief", *pagan, pantheistic,* and *biblical.*[1509] It should be noted that Clouser takes "religious belief" to mean "any belief in something or other as divine", defining "divine" as "having the status of not depending on anything else".[1510] This makes a materialist atheist as "religious" as a theist, insofar as he believes that matter (i.e. space and time) and the laws of nature – rather than God or the gods – are self-existing. Similarly, irreligious individuals may nurture what in Clouser's terminology amounts to "religious beliefs" concerning the validity of mathematics, the laws of logic, the laws of nature, etc. In the *pagan* belief system, the *divine* is held to be *part* of the total *reality.* This kind of belief is typical not only of ancient pagan religion, but also of much philosophy and science, both ancient and modern, in which reality typically is *reduced* to one (crypto-)divine principle, such as matter (materialism) or mathematics (Pythagoreanism), or, in a dualistic variation, to two, often antithetically valorised principles, such as matter and form in the Platonist tradition, Ormuzd and Ahriman in Zoroastrian religion, or yin and yang in Taoism. In the *pantheistic* view embraced in Hinduism and Buddhism (according to Clouser at least), *reality* is instead held to be part of the *divine,* whereas in the *biblical* view adopted in the Abrahamitic religions and also advocated by Clouser himself, the divine and the universe are separate realms, where the latter is created by, but distinct from, the former. Furthermore, Clouser argues that all theories, also *prima facie* religiously neutral mathematical and scientific ones, are regulated by "religious belief" and sets out to refute "the myth of religious neutrality". Although those who do not share Clouser's apologetic intentions may be a little put off by his provocative choice of terminology and one may opine that in reality the division lines he proposes may neither be as stark as he contends, nor necessarily the ones leading to the most natural and relevant classification,[1511] it must be acknowledged that he makes a very important point when he stresses that there is

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[1506] See [Voeg78] and [Voeg96] p. 78 et seqq.

[1507] Cf. also [Jasp94] p. 39 et seqq.

[1508] See [Port49] and [Samb81].

[1509] [Clou91].

[1510] Id. op. p. 21 et seq. This property of self-existence was referred to as *aseity* by the scholastics. One is also reminded of Wilamowitz' famous observation that the Greeks used 'god' predicatively about anything they found worthy of wonder. Cf. also [Coll60] p. 104 et seq.

[1511] For instance, the fundamental Christian tenet that Christ is "born before all time" and not created in time can possibly be taken to imply (although this is not beyond dispute) that the plan and archetypes of creation being part of *Logos,* i.e. Christ, including the logical, mathematical, physical, and other institutes that govern the regular order of the cosmos (or at least some of these) are also to be regarded as uncreated, and, thus, in Clouser's terminology as "divine", which absurdly seems to lead to the conclusion that Christianity is partially "pagan". In fact, Clouser, trying to guard himself against the Scylla of such "paganism", seems by his "pancreationism" to end up

in every man a fundamental direction, desire, will, or intentionality, which one may provisionally call 'religious faith', and that the object of this, be it the *visio beatifica* of Christianity[1512] or some – 'self-existent' or other – idol, influences his *Welt-* and *Lebensanschauung* decisively and, indirectly, most probably any scientific theories he devises or entertains as well.[1513]

In the beginning of this section, I expressed some reservations about the general usefulness of the different varieties of the sociological approach to worldviews. The limited adequacy of such approaches can easily be perceived by the fact that a man's outer profession of a certain worldview often is not in harmony with his inner convictions – thus the sociological view can at best give us an incomplete and rather shallow understanding of the worldview issue. Nor do I think that psychological typology, albeit by no means worthless, has made us really comprehend what is going on when a man adopts a certain worldview. We must, I contend, remember that in the end men are not the abstract constructs, ideal types, pawns, and social animals, which the sociological and psychological theorists, political propagandists, and Darwinist nihilists would reductionistically have them be. On the contrary, each man, however unassuming his situation in life may be, is a real, responsible, sensing, feeling, and thinking human being – even created in the image of God, if we are to trust something as old-fashioned as the *Genesis* account. As such a kind of being, he will sometime in life, usually as he comes of age, make some fundamental existential, moral and religious – or pseudo-religious (such as politico-philosophical) – commitments, by which he will then lead his life, at least until he is prompted to change them again, as will perhaps only seldom happen. Although these commitments of the heart will in a pluralistic society typically be represented symbolically by the espousal of a certain worldview, they are, I contend, essentially about something else, to wit a few stark existential choices between ever-present polarities, such as faith or disbelief, a life of honesty or one of crime or hypocrisy, obedience to or rebellion against God, unselfish service of others or corrupt selfishness, in short, if we may use religious language, the choice between God or the Devil. Thus, we would perhaps be better off, if we, as Clouser suggests, focus on "religious beliefs" rather than worldviews, or at least recognise that there is a hierarchy of beliefs, where "religious beliefs" are prior to the more sprawling and tawdry structures of worldviews and ideologies.

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dangerously close to the Charybdis of Arianism and Mohammedanism, even claiming that God's own properties are created by Him rather than uncreated (see [Clou91] p. 176 et seqq.).

[1512] Cf. [Luba65].

[1513] If we make religion the basis of our categorisation, but also want to honour the aforementioned distinction between exclusivism, inclusivism, and pluralism, we may end up with a scheme quite different from Clouser's, one of a more socio-historical tendency, distinguishing between categories, such as:

- *orthodoxy,* which sticks to a traditional, orthodox strain of one of the great religions, attempting to protect the core of the religious doctrines through scriptural and dogmatic fixation and traditionalism (in Christianity primarily the Eastern Orthodox Churches, traditional Roman Catholicism, the High-Church party of the Anglican Church, and Orthodox Lutheranism)
- *sectarianism* (or *heterodoxy),* which comprises the proliferation of schismatic sects and cults that attempt to reform, renew, or change some aspects of the orthodox religion according to some special intuition, sentiment, or inspiration by making a break with orthodoxy (in Christianity the many nonconformist churches as well as various more radical religious movements and sects that may or may not be properly classified as Christian)
- *eclecticism* (or *syncretism),* which strives to reconcile different religions by identifying some kind of common core in them or by choosing from each what is deemed good (e.g. some varieties of Christian Platonism based on the concepts of *theologia prisca* and *philosophia perennis* as well as more pure forms of 'philosophical religion' and deism, modern perennialism both of the esotericist and the more scholarly variety, theosophy and much of the *New Age* spirituality, and some varieties of deistic-rationalistic, Romantic-pantheistic, liberal, and modernist theology, such as, for instance, Whiteheadian process theology)
- *naturalism* (or *atheism),* which considers all religious ideas and claims to be vacuous, inherently suspect, or just uninteresting (mainly various forms of atheism, agnosticism, free-thinking, or just indifference to religion, but also the more bellicosely anti-religious secular humanism and the anti-Christian or anti-religious mindset embraced by many academic theologians and religious scholars in the liberal tradition going back to Reimarus, Strauss, and Renan and presently epitomised by, for example, the spirit of the infamous 'Jesus seminar')

This scheme seems to suggest a *historical* progression with *orthodoxy* at its head (or perhaps rather the primordial unity predating the division between orthodoxy and heterodoxies), *sectarianism* as a reaction against some aspects of the current *orthodoxy* or against its degeneration and ossification, in its turn prompting the response of *eclecticism* as an attempt to overcome the proliferation of sects as well as that of *naturalism* as a sceptic reaction to the resulting dogmatic diversity. Furthermore, this scheme has a *sociological* bias insofar as what is deemed *orthodox* and *heterodox* will differ with different societies and times, at least when looked at from the socio-historical perspective: *Orthodoxy* amongst Indian Hindoos of, say, Shankara's times is obviously not the same thing as *orthodoxy* in Catholic Italy in the days of Aquinas, or in present-day Communist China. The prime drawback with this kind of categorisation from the point of view of *Weltanschauungen* thus is that it stresses contingent socio-historical factors at the expense of the idea content of the worldviews.

Additionally, if it is true, as Kuhn and Feyerabend would have it, that all scientific theories are born refuted, as there will always exist anomalies that give the lie to them, this will be even more true of such all-embracing compages as worldviews. To the Christian mind, all this never-ending philosophical-scientific speculation and artificial construction of novel worldviews, so eagerly engaged in by modernist and postmodern intellectuals – albeit in dead-earnest only by the former and just tongue in cheek by the latter –, will appear pretentious and futile or even fundamentally opposed in spirit to the simple Christian virtues of faith, hope, and charity, looking suspiciously like the outcome of the egophanic self-complacency of modernity with its brazen refusal to approach truth and being openly, in its turn the upshot of man's self-inflicted spiritual blindness and error, that is to say of the mortal sins – and of them, above all, of course, pride – and, ultimately, of the Fall of Man.

A world which embraces the miraculous is necessarily a radically different reality from one where such events are impossible, or even the thought nonsensical.

T. C. Williams[1514]

Religion dismisses the psychic aspect of life at its peril.

M. Perry[1515]

Having surveyed some useful attempts to systematise worldviews and also having briefly contemplated the forces at play during the formation and choice of a worldview, let us now take a quick look at science from the perspective of worldview typology. Firstly, it should be emphasised that the metaphysical presuppositions inherent in the worldview, to which a scientist or scholar subscribes, will have a very decisive influence not only on his interpretations of data, but on how he does research in a very general sense, how he sifts out the problems he deems worthy of study, how he selects the facts and data to be taken into consideration, how he arrives at the theories and conclusions he does, etc. In his little book on heresies, Hilaire Belloc provides us with one striking example – by the way, descanted on also by various other authors – of how metaphysical presuppositions condition research, viz. how the belief or non-belief in the possibility of miracles amongst Biblical scholars creates totally incompatible interpretations of the gospels.[1516] Thus, scholars, who, following Hume and the predominant naturalist worldview, hold miracles to be impossible, will present us with some kind of deconstruction – or, perhaps rather, destruction – of the gospel narratives entirely at odds with the more traditionalist accounts presented by those who hold that miracles, albeit anomalous from a naturalist point of view, happen anyway.

Secondly, it is evident that what is going on in present-day science, insofar as it has any palpable metaphysical bearings, as it indeed often has, is – with very few and infallibly extremely contentious exceptions – strongly biased towards Poortman's *Alpha* standpoint and the naturalistic-materialistic end of the worldview spectrum – thereby incidentally also lending support to the thisworldliness and sensate and anti-religious agendas of modernism and postmodernism. Outside theology and a few other mostly very small and controversial and largely extra-academic disciplines, such as psychoanalysis, non-Darwinist biology, psychical research, ufology, cryptozoology, and suchlike, which, if noticed at all, are frequently denounced as "pseudo-science" by the vigilantes of scientific naturalism, it will be difficult to find such straightforward examples of the significance of metaphysical assumptions as Belloc's belief-in-miracles case, not because they are unimportant or non-existing, but for the simple reason that any scientist who dare call the prevalent naturalist presuppositions into question or make his starting-point some of the anomalies that apparently undercut them is likely to become immediately marginalised and muzzled by his colleagues, often through the most astonishing and iniquitous acts of intolerance.[1517] As we will see later, it is possible to trace the origin of the naturalist

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1514 [Will90b] p. xiii

1515 [Perr84] p. 27

1516 [Bell91] p. 2 et seq.

1517 For some lugubrious case stories, see [Milt96] (see also http://www.alternativescience.com), [Mart97], [Ingl86], [Berg84], [Berg96], [Graz78], [Schi95], [Jaki78] p. 64 et seqq., [Jaki85] (cf. also [Jaki84]), [BS87] p. 330 et seqq., [CT99], [Well00] p. 235 et seqq., and [Arp98] p. 257 et seqq. Although scientists' proneness to dogmatism, herd mentality, prosecution of cognitive minorities, and the veneration of sacred cows are both well-known and well-documented (see e.g. [Kuhn70] for some colourful descriptions; cf. also [Bour96] and [Berl99] p. 110 et seqq.) and have been given plausible interpretations by sociologists of science in terms of (veiled) vested interests, group dynamics, cognitive dissonance, and the like (see e.g. [McCl84], [Wall79], [Maus79], and [Fest57]), the vehement and narrow-minded ill-will that regularly meet dissident scientists still seems no less astonishing than appalling in view of the stock scientific rhetoric concerning the importance of an open mind and a free search for the truth, of the wide recognition of such virtues as caution, restraint, and gingerly circumspection in the scientific discourse, of the immense reverence conferred upon paradigmatic dissenters and heroic cranks, such as Galileo, Kepler, and Wegener, and of the nowadays rather general awareness of the dangers of the aforementioned faults resulting from the popularity of the widely read works by Kuhn and other knowledge sociologists.

Partly, the doctrinaire narrow-mindedness of many scientists demonstrated by their unprepossessing behaviour towards dissenters may perhaps be accounted for by the massive specialisation of present-day science, whereby scientists, typically being narrowly preoccupied with their own field of expertise and their own career, holding naïve and panegyric views about the theory of science as well as of their own importance and level of insight, and lacking a sound understanding of the significance of metaphysical presuppositions – including

prejudice of science to a particular historical setting and show how it, albeit now perhaps appearing as the infrangible bedrock of the scientific pursuit as well as the modern scientific worldview, was once begotten by historical contingencies and only later, having been coupled to various anti-religious and pseudo-Messianic agendas, was forged into the ersatz religion of scientism that now rules the roost of Western civilisation.

It is often argued by the advocates of scientific materialism that the naturalism of science is quite in order and not a manifestation of any illegitimate metaphysical bias, but just the consequence of the compelling naturalistic inferences that have resulted from the amassed output of scientific research. I will discuss the validity of this contention at some length below, but some of its unfairness can immediately be seen by considering how a research proposal making only passing mention of some essential non-materialistic concept, such as "spirit", "soul", "ghost", "spiritual being", or "subtle matter" – to say nothing of "survival of bodily death", "God", "grace", "providence", "angels", "demons", "heaven", or "hell" – would be expected to fare in a process of application for research grants. Certainly, a researcher (of course, outside history, ethnology, and other similar disciplines, which study *beliefs* about such concepts without taking the concepts themselves seriously) who ventures to write something as foolish as that in an application would rightly be considered a crackpot.[1518] Indeed, non-materialistic metaphysics has become so stigmatised that it may be most injudicious for a scientist to make use of its terminology in private conversation with a colleague or even an intimate friend, nay even representatives of the clergy occasionally seem embarrassed by it. This granted, a naturalist may contend that research on such matters is not allowed by the scientific method ("methodical naturalism") or that it simply is "not science", which, of course, in actuality amounts to little more than an allegation that science by its very nature should be biased towards naturalism and that all other metaphysical perspectives are to be prohibited. *Sic volo, sic iubeo*…

Thirdly, the current predominance of the naturalist worldview is not, I contend, the result of its own preeminence or truthfulness, but, as we will see in the sections to come, can only be upheld by the systematic negligence of the most obtrusive anomalies and by the magic of vehement rhetoric and sophistic trickery. One reason why the fundamental incompleteness and precariousness of the naturalist worldview of science largely go unnoticed is to be found in the widespread scientific myopia that follows on the enormous fragmentation and specialisation of science with its splitting-up of existence into separate realms of reality and study, between which more or less impassable barriers have been erected, only occasionally to be penetrated by more or less nugatory interdisciplinary tunnels, entirely inadequate and unable to overcome the overwhelming deleterious, truth-obscuring effects of scientific specialism and isolationism.[1519] This compartmentalisation is of course primarily reflected in the boundaries between the different scientific disciplines – physics, chemistry, biology, psychology, sociology, astronomy, etc. –, but in fact goes much deeper than that, as each branch of science is in turn partitioned into a large number of specialities, amongst which there is generally only very limited exchange of ideas. Thus, the students of different topics, rallying around a certain theory or paradigm into various "communities of belief", divide the study of the world up into a plethora of small principalities and fiefdoms, over each of which a few expert groups are usually accorded the exclusive authority and sway.

Through the immense authority and prestige bestowed upon these specialists within their respective domain of expertise together with the mostly highly uncritical and blinkered commitment of the scientific cenacles to their own – almost unexceptionally naturalistic – metaphysical and other presuppositions, the semblance and grand fata morgana of a unified naturalistic worldview are conjured up, both amongst the scientists themselves and in the public mind, overwhelming and intoxicating through the seeming grandeur and austerity of the all-encompassing picture that seems to emerge – Big Bang, evolution, genes, quarks, quantum theory,

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their own ones – and the fundamental inadequacy of scientific materialism, are lead to believe they really are the guardians of rational discourse rather than its grave-diggers, when they stifle and suppress research they for one reason or other disapprove of. But there also seems to be amongst many scientists a neurotic, at times even obsessive or almost demonic streak of fear and denial of anything spiritual, the roots of which are, in spite of the suggestions made in the previous section, not always easily grasped or comprehended. An interesting recent study partly dealing with these issues is [Hans01b].

1518 Still some scientific research is pursued on such controversial topics, by necessity largely supported by the generosity of private donors rather than by regular funding. Researchers dedicated to the investigation of contentious areas often have to resort to very flexible tactics in order to survive, e.g. by creating small dissident communities, which may provide for their own sheltered publishing channels and discussion fora, by trying to find powerful protectors, by taking prudent advantage of the often great public interest and appeal of such subjects, by avoiding unnecessary skirmishes with the guardians of scientific right-thinking, and so on. See [Mart98a].

1519 See above p. 287

superstrings, etc. – and the astonishing magic-miraculous feats of technology used to confirm its validity – flying in the air, healing the sick, creating terrible bombs, putting man on the moon, cloning sheep, building robots and machines that play chess and compute pi down to the zillionth decimal, etc. But when we start to consider and scrutinise the metaphysical and other presuppositions of the scientific theories as well as the interdependencies of all these presuppositions, which typically rest on the presumedly unshakeable theories of some other branch of knowledge that, in turn, will hinge on yet other ones and so on and on *ad infinitum,* it transpires that the chains of presuppositional dependencies together form, as it were, a giant house of cards, of which, on closer inspection, some, however, turn out to be but phantoms, fraught with difficulties and anomalies, which, if taken seriously, would render them null and void, and apparently having been called into existence by the structural needs of the card house rather than as a result of an open quest for the truth about being.[1520] Although scientists often are well aware of the problems of their own narrow field of special interest, they have, as pointed out by Kuhn and other knowledge sociologists, a peculiar penchant for papering over or angrily discarding anything that is not to their liking, that creates cognitive dissonance in their minds, that is anomalous from the point of view of the paradigm and regional ontology they embrace, and that, accordingly, threatens both their own vested research interests and the entire rickety card house of the naturalistic scientific worldview. At that, they tend to put almost unlimited faith in the authority of the experts of other fields, which are strangely believed to be exempt from the anomalies and difficulties found in their own area, and to treat any widely accepted theory outside their own narrow domain of interest with the greatest credulity, even though this theory may be an important presupposition for their own theories, thereby helping to make these huge chains of dependencies of ultimately, as it appears, only loosely founded assumptions gain the status of a most compelling *de rigueur* structure. But what is the point of this conjured-up worldview, if it is but a sham? And why all this high-strung rhetoric to prop it up and the often frantic attempts to cover over and deprecate the anomalies that threaten to tear it down? What hidden and deep motives and forces drive this bellicose intransigence of the advocates of scientific materialism? How do these attitudes relate to the thisworldliness and sensate culture of modernity and its political and anti-religious agendas? Such are some of the questions that we will cope with in what follows.

In contrast to present-day science with its one-sided commitment to metaphysical materialism and naturalism, almost all significant pre-modern thought – or *traditional thought,* as I will refer to it below – resides safely within Poortman's *Beta* to *Zeta* standpoints and, in the general case, tend to bolster ideational or idealistic attitudes and at least some degree of otherworldliness. Although we must not overlook the very substantial discrepancies that exist between the various traditional worldviews, as they have come down to us in religious, philosophical, and other literature from different ages, in the great world religions, in various philosophical "systems", and in the ideas and practices prevalent in different forms of 'primitive' (i.e. pre-literate) culture, there is also a very substantial concurrence between these pre-modern conceptions in some of their basic assumptions about the world.[1521] Considered as an ideal type, "the traditional worldview" may be characterised by four specific, very fundamental beliefs, rejected out of hand in most varieties of the equally ideal-typical "modern worldview".[1522]

Firstly, in the traditional worldview it is unanimously acknowledged that there exists a *spiritual world,* a suprahuman reality, a mundus imaginalis, an "other" or "next" world, which somehow both transcends the present world and overlaps with it.[1523] Furthermore, this otherworld is believed to be populated by various

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[1520] After having written this, I found the article [Hein94], where a similar line of argument about the scientific worldview as a house of cards is found, although the basic tenor in this piece of writing is entirely at odds with my intentions.

[1521] In order to re-construct the common denominator of the traditional, pre-modern worldviews, we will primarily consider the results of the phenomenology and comparative study of religion, to which a reasonable introduction is provided by [Pett72]. When trying to understand the beliefs of former ages, we must of course beware of projecting modern expectations and theories onto the past, a fault still often perpetrated also by the most erudite and prudent scholars. In particular, we must not again and again commit the chronocentric-evolutionary fallacy of treating all men who have lived before us as inferiors, interesting only as the backdrop of our own times.

[1522] A more dogmatic attempt to describe "the traditional worldview" from the standpoint of esotericist traditionalism à la Guénon, Burckhardt and Schuon is provided in [Vers91], whereas [Lewi64] provides a scholarly outline of "the discarded image" of the pre-modern Western worldview.

[1523] The seeming disappearance of this world in the modern West – the process that Max Weber, following Friedrich Schiller, called "Entzauberung", disenchantment (see [Webe34] p. 94 et seq.) – was apparently prefigured by its extreme pathologisation and demonisation during the Renaissance, Reformation, and "the scientific revolution", as reflected, for example, in the witch-craze and the demonomania of Hieronymus Bosch's paintings. Eruditely, but unconvincingly, [Merk98] argues that various Islamic Gnostics, notably al-Sijistani, al-Suhrawardi, and Ibn al-Arabi, are to be credited with – or blamed for – the creation of the notion of an "Otherworld" separate

beings different from the ones of our usual physical reality, such as spirits, angels, demons, the souls of the departed, various divine or folkloristic beings, etc. The geography of the otherworld will be diversely conceived, but, as a rule, it is assumed to be structured hierarchically, typically accommodating locations, where the souls of dead sinners are punished and those of good men and heroes get some kind of recompense.[1524] Albeit usually not directly perceptible, at least not to ordinary men – though the capability for such 'spiritual perception' will be culturally conditioned and apparently has progressively tended to fade away during the course of history –, the spiritual beings of the other world are not shut off from the present world, but are held to be capable of interacting with it through a wide range of practices handled primarily by various experts in the supernatural, such as shamans, oracles, mediums, certain priests, etc. Mostly, the interaction with these beings is considered to be a delicate, parlous, or, in some cases, condemnable business, which, in particular if inexpertly dabbled in, is apt to have dubious or dangerous effects or, in more extreme cases, to lead to abnormal spiritual-psychological states, such as spirit obsession or demonic possession, since many, if not most, of the powers of the other world are believed to be hostile to man, taking delight in causing mischief, disorder, and calamities unto him. Notably, the monotheistic Abrahamitic religions, with some well-circumscribed exceptions, strongly disapprove of meddling with such otherworldly beings, but thereby by no means denying their existence.

Secondly, in the anthropology of the traditional worldview man is universally agreed on to be more than just his body, in addition to which he is assumed to have a ***soul,*** which acts as a kind of vehicle, sheath, or substrate for his innermost self, spirit, personality, or identity and also survives the bodily death.[1525] Also

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from the usual physical reality, as they, by giving up the stark Platonic dualism between matter and immaterial ideas and instead introducing a tripartition between essences (ahylic or transcendent ideas, ideas *ante res),* forms (enhylic or immanent ideas, ideas *in rebus),* and matter, "validated visionary experiences by placing imaginables on a par with perceptibles". The last touch to the idea of the Otherworld was put, we are told, by Paracelsus, who made ether (i.e. subtle matter) – a concept, which had been given a new significance by Ficino, who, on the basis of Neoplatonist ideas, coupled it to sense perception – the material of the other world, which, thus, was given "an orderly, proto-scientific basis" that made it "credible not only for occultists, but for any educated person".

But, firstly, the almost inescapable distinction between transcendent and immanent ideas – or **□δ□αι** (or *νοητά*) and **ε□δη**, as were the *termini technici* used for these concepts in late Antiquity –, besides being of doubtful importance for the process considered, has been a stock feature of Platonism since early times. Certainly, it is much older than al-Sijistani, being discussed at some length by, for example, Albinus, Seneca, and Alexander of Aphrodisias, and may go back to Plato himself (see [Dill77] p. 136 et seq. and p. 274 and [Merl63] p. 16 et seq.). Secondly, while there is no denying that the "imaginal" has become exceptionally alienated from the physical cosmos in the modern world, the borderline between the two realms was not absent before this great alienation took place, as reflected, for instance, in such arresting symbols as the passage to the netherworld over the river Styx in Charon's bark or the sphere of the Moon as the boundary of the celestial, superlunary realm. Significantly, the term "the other world" has itself been used to designate the spiritual world by different peoples around the world since time immemorial (see [Pett57] p. 147 et seq.). Thirdly, the notion of the fine-materiality of the Otherworld was not the feat of Paracelsus, but, as shown in the four volumes of [Poor78], has a long and very complex history and, indeed, was a much debated topic both in the Middle Ages and during the Renaissance, nor will Paracelsus, for all his influence, be plausibly accredited with the ubiquitous belief in the reality of the Otherworld amongst educated persons at this time, inasmuch as this belief certainly already was prevalent when Paracelsus appeared on the stage. Fourthly, the alienation of the "imaginal" from the current cosmos, seemingly reflected in the concept of an "Otherworld", hardly has much to do with the Islamic theosophers, but will much more plausibly be the consequence of the establishment of the scientific mechanistic-materialistic worldview, in which there simply is no place for the imaginal within the cosmos. For one thing, the extraordinary alienation of Western modernity from the spiritual world is strikingly symbolised by the flight through the dark tunnel from the present world to the hereafter reported by so many Western near-death experiencers, but, according to [Kell96], being absent in non-Western accounts, as though the current world and the otherworld had been driven asunder by the adoption of the modern worldview – exactly when the tunnel experience crops up in the records I have not been able to find out (cf. [Zale87] p. 121 et seqq.), but it seems to be depicted already in a famous painting by Hieronymus Bosch (see [Grof80] or [Borc94] p. 336).

1524 See [Pett57] p. 204 et passim.

1525 See [Pato21], [Brem79], [Arbm26], [Hult53], [Paul58], [Paul60], [Find60], [Fisc65], [Poor78] vol. I p. 70 et seqq. and vol. II p. 17 et seqq., [Pett57] p. 41 et seqq., and [Pett72] p. 55 et seqq. Many recent observers, including [Pett72], have criticised the unified conception of the soul allegedly projected onto the disparate ethnographical material by earlier generations of scholars, who uncritically espoused, for example, Tylor's and Spencer's animism or some other overarching 'paradigm'. On the other hand, many of the more recent "differentiated" interpretations will upon closer scrutiny look as doubtful, biased, and prejudiced as those of the "universal animism" of yore, and the tendency to replace "universal animism" with a chaos of divergent conceptions can certainly go too far – after all there is not only diversity, but also a very real unity in the conceptions of the soul across the world, and the diversity there is will rather be one of nuances and details than of essentials and fundamentals. In particular, much futile scholarly quibbling and misunderstanding could have been avoided, if there in learned circles had been a more general familiarity with paranormal phenomena, such as the so-called out-of-the-body and near-death experiences, which doubtless provide an important backdrop to the traditional conceptions of the soul.

Although I will not here call into question the intriguing thesis – suggested by various scholars of religion and applied to the conceptual development of the ancient Greeks by [Snel80], [Onia51], [Dodd73a], and [Brem79] – that primitive man does not conceive of himself as a unified self, but rather as an assemblage of parts, physical limbs as well as spiritual 'function-souls' (indicated by such Homeric terms as

during his present life, man can, in principle at least, leave the body with his soul – often then referred to as the "free-soul", "external soul", "astral body", or the like – and tour this or the other world. Such journeys are regularly engaged in by certain religious experts, such as shamans and medicine men, although also ordinary men may occasionally experience them, in sleep or due to, for example, illness, a casualty, or some other incidence. The soul is often conceived of as having the same form as the body, albeit much more ethereal and breath-like in its substance, frequently being likened to a shadow, but can also be thought of as a minute copy of the body, a manikin, or as having the shape of a bird, a butterfly, a snake, a mouse, or some other animal or being. At death, the soul is thought to depart from the body to some location in the otherworld, although it may also for various reasons choose to linger in the present world as a ghost.[1526] Often, there exist in addition to the aforementioned "free-soul" or "astral body" terms for various "function souls", which are usually associated with certain organs of the body and are not believed to survive death. The most important one of these, will be the "life-soul", "body soul", or "life-principle", which mostly is associated or identified with the breath or the blood ("breath-soul" and "blood-soul") and is held to lend life to man. Commonly, the life-principle is assumed to have been given by God or the gods, to whom it also may return when a man dies, but it may also coalesce with the free-soul or be conceived as a part or aspect of it. In addition, some kind of guardian spirit, guardian angel, genius, or alter ego will often play an important rôle in traditional anthropology.[1527]

Thirdly, being and the ordered cosmos are in the traditional worldview derived from an ultimate source, a *Supreme Being,* from which the present cosmos somehow emerges through creation, emanation, projection, or suchlike, conceived of, implicitly or explicitly, as a process where the world takes form in accordance with a master plan or a set of archetypes resident in the "mind" of the Supreme Being. Although a good – albeit admittedly speculative and controversial – case can be made for the thesis that the most primordial form of religion essentially was a kind of ethical monotheism or, as some prefer to put it, a belief in a creator "high god"[1528], no one can doubt that during the course of history a tremendous conceptual diversity has

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noos, thymos, menos, phrenes, etor, kardia, etc.), and that this weak, aggregate conception of the ego only gives way to a more clear-cut sense of individual self, as literacy and political life develops, which in ancient Greece would have happened during the classical period (6th-4th centuries B.C.), the related interpretation of the prevalence amongst many pre-literate peoples of different terms for the "ego-soul" active in the normal waking state (presumably the Homeric *thymos* or *noos)* and the "free-soul" (i.e. the Homeric *psyche),* in which man may travel out of the body in dreams, trance, swoons, and after death, as implying that primitive man, lacking any real sense of ego, did not equate the 'I' active in the waking state with the 'I' travelling in the free-soul certainly is exaggerated and unbelievable. It may well be that the term "free-soul" is misleading – rather than a 'soul' in the usual, present-day acceptation of the word the concepts subsumed by the term "free-soul" appear, I think, to denote a *vehicle* of the soul or the 'I'. Additionally, those making primitive man exceedingly strange and mysteriously unlike ourselves should ask themselves if they are not overegging their pudding – after all, the unprejudiced student of Homer is more likely to be struck by Homeric man's humanity and tremendous similarity to ourselves than by the peculiarity of his psychological constitution!

1526 There are of course many variations in the beliefs about what will happen to the soul in the long term – amongst the more widespread ideas are resurrection and metempsychosis. These beliefs are, in turn, intimately associated with the different religions' macrohistorical theories, which, being quite diverse and complex, will not, however, be discussed here. Cf. [Baar74].

1527 See [Nitz75] and [Jova95].

1528 On the basis of a huge ethnographical material, Graebner's diffusionist, anti-evolutionary theory of *Kulturkreise,* and Andrew Lang's seminal observations about the "high gods of low races" and critique of Tylor's animist theory of the origin of religion in [Lang1898], Wilhelm Schmidt, in his monumental, 12-volume work *Der Ursprung der Gottesidee* [Schm26], set out to show that the religion of the most primitive peoples of the world – hunter-gatherers living in sequestered regions, supposedly not much influenced by "higher" cultures – and, thus also, according to Schmidt, the primordial religion of man was a kind of *Urmonotheismus,* a belief in a good Father in Heaven, a Creator God and Supreme Being, who, according to these peoples' myths, had communed with mankind directly on Earth in a distant *Urzeit* and taught it the ethical commandments and the *Urreligion* traded down by themselves ever since, but later, due to some kind of sin or mistake perpetrated by man, had withdrawn to His current celestial abode, from which He, omniscient, omnipotent, and invisibly omnipresent in His creation, still takes an active interest in men's doings, also being worshipped – though notably not represented by any idols – through prayer, various rituals, and the sacrifice of first fruits. Collaterally with various cultural developments and influences, religion, however, soon tended to degenerate in different ways, which Schmidt also tried to map systematically through the doctrine of *Kulturkreise,* which he developed in significant ways. His work was continued by various scholars of the Vienna school, such as Koppers and Schebesta. See [Schm26], [Schm30], and [Schm36]; cf. also [Paja78], [Bran90], [Radi54], [Kopp55], [Sche61], [Roon93], [Rivi00], [Grah00a], [Span47] p. 313 et seqq., [Mbit69] p. 29 et seqq., [Albr57] p. 101 et seq., [Shar75] p. 172 et seqq., [RS78] p. 13 et seq., and [Pett72] p. 81 et seqq. Non vidi Ernest Brandewie's *Wilhelm Schmidt and the Origin of the Idea of God.* Some of the criticisms passed on Schmidt's theories are summarised in [Zimo86], [Pett72] p. 86 et seqq., [Radi57b] p. 254 et seqq., and [Okee83] p. 160 et seqq. Although Schmidt was not able to establish "the ethnographical proof for the existence of God" that he dreamt of in a way compelling to scholars of a secular or anti-religious bent and his theory of *Kulturkreise* was, as pointed out by many of his own disciples, problematical in various respects, he nevertheless greatly conduced to the final demolition of the credibility of the then predominant evolutionary theories of

supervened amongst the different traditional cultures and religions both as to the nature and characteristics of this ultimate source of the ordered universe and with reference to its relation to the physical and spiritual worlds, the human soul, and the ethical precepts, by which man is to lead his life.[1529] Additionally, in many cultures this Supreme Being or ultimate source of being has become more or less overshadowed, or occasionally even totally ousted, by the imaginal sphere and its plurality of lower divinities, which originally, it seems, may have been considered hypostases, emanations, aspects, ideas, split-offs, intermediaries, viceroys, or suchlike of the Supreme Being.[1530] For all its interest, we cannot here penetrate further into this immense topic, but will have to content ourselves with the somewhat dogmatic statement that in the traditional view there is a Supreme Being, a God, from whom the cosmos derives.

Fourthly, the traditional worldview is underpinned by *miracles,* i.e. various phenomena, which apparently deviate from the ordinary course of nature and, by defying the 'laws' that science assumes regulate nature and calling into question its basic presuppositions, present the modern scientific-materialistic worldview with anomalies, with which it has so far been unable to come to terms in any sensible way.[1531] Instead, these kinds of anomalous – "supernatural", "paranormal", "miraculous", "mystical", "occult" – phenomena are more or less regularly ignored, dismissed out of hand, scornfully derided, or flippantly and pompously 'debunked' by the scientific-philosophical élites whose metaphysical predilections and claims to hegemonic expertise they apparently challenge.[1532] Notably, these anomalous phenomena are not only allowed for and of crucial significance in the traditional worldview, but they have repeatedly lead independent researchers, who, taking them seriously, have tried to understand their real nature, to arrive at conclusions and form theories and conceptions reminiscent of or similar to important elements of the traditional understanding of the world.[1533]

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religion – worked out by Hume, Comte, Tylor, and many others – and also succeeded in conceiving a respectable Christian alternative to the secular hypotheses as to the origin and history of religion, based on the idea of an *Uroffenbarung.*

[1529] The different conceptions of the 'divine source' of the cosmos range from a theistically conceived personal creator God over the unfathomable divinity of mysticism and various panentheist, pantheist, and deist schemes to an entirely impersonal, anancistic or tychistic 'world order', reminiscent of the 'laws of nature' of scientific materialism. Whereas some of these conceptions appear to be logically incompatible, others have been creatively combined by those of an irenical-syncretistic frame of mind.

[1530] As pointed out by [Pett72] p. 93, the Supreme Being is sometimes conceived of as comprehending the entire imaginal sphere with its angels, gods, spirits, etc. On the concept of "primitive Platonism", which will be of crucial importance if we want to reconstruct a plausible scenario for how these developments came about, see footnote 1559 on p. 320.

[1531] For example, [Lang1898], [Vesm31], and [McCl94] strongly emphasise the importance of such phenomena to religion. Cf. also [Bozz75], [Lang42], and some of the papers in [AB74]. On the present ban on miracles, see footnote 1580 on p. 324 below.

[1532] Kuhn and Feyerabend submitted that anomalies exist for all scientific theories (see [Kuhn70], [Feye93], and [LM74]), that every theory is in fact born refuted. An impressive number of collections of anomalies gleaned from scientific and scholarly journals has been published by William R. Corliss in the *Sourcebook project* (see http://www.science-frontiers.com). Albeit somewhat less fastidious in his choice of sources, making, for instance, some use also of excerpts from newspapers, the late Charles Fort, whose famous collections of anomalous data, often of a rather bizarre character (see [Fort74]), gave rise to the term 'Forteana', is widely regarded as the father of current anomaly research. An amusing, learned, and up-to-date survey of the field of "anomalistics" (as it was named by the anthropologist Roger Wescott in [Wesc80]), the most vital branches of which currently will be ufology and cryptozoology, is provided by [Clar99a], who also supplies extensive references into the rich literature on these topics. Some other such more or less useful surveys of the "unexplained" are [Hitc79], [WG81], [Evan89b], [Shuk96], and [MR00]. The huge annals of psychical research, parapsychology, and various other so-called parascientific efforts constitute another corpus of anomalies (see footnote 1579 on p. 324 for a few literature suggestions), religious miracles proper yet another – see [Greg11], [Arad56], [Hell52], [Thur52], [Lero35], [Lero51], [Smit65], [Rahn63], [Tree88], [Tree93], [Tree01], [Cruz77], [Cruz84], [Cruz87], [Cruz93], [Cruz95], [Heba86], [Scha68b], [LJ87], [Laur88], [Zieg95], [HN98], [Beev54], [Dela61], [KJJ96], [Ruff82], [John98c], [Newm1890], [Tonq16], [Tonq55], [Knox], [Wies57] (Christian, mostly Roman Catholic perspective); [Benz69b], [Wood00], [Chri81], [Chri92], [Chri96], [Blac95], [Krei78], [McCl83], [Zimd92] (comparative religion/anthropological/historical perspective); [Evan84], [Evan87], [Wils88], [Rogo91], [Gros92], [Murp92], [McCl94], and [Jova95] (parapsychological/Fortean perspective); cf. also [Hayn70] and [Wils83], which includes a short bibliography of the literature on saintly miracles on p. 390 et seqq.). Useful, despite its perversity, is also [Cobh66]. Innumerable saintly miracles are documented in works such as Andreas Resch's series *Wunder von Seligen und Heiligen* (original title *Miracoli dei Beati,* published in *Sussidi per lo studio delle cause dei Santi),* Alban Butler's classical *Lives of the Saints,* the Bollandistes' *Acta sanctorum* (now also gradually becoming available online at http://acta.chadwyck.com). An interesting case study, which stretches the common conceptions about the limits of what can be achieved by paranormal means, is [Mish00].

[1533] Besides the survival and spirit hypotheses, the subject of seemingly endless argument between the adherents of "animism" and "spiritism" all since the inception of psychical research, such theories and concepts as Vallee's "Magonia" (see [Vall93]), Keel's "ultraterrestrials" (see [Keel75] and [Keel95]), Clark's and Coleman's "otherworld" (see [CC75]), Holiday's "goblin universe" (see [Holi86]), Evans' "entity" and "encounter experience" (see [Evan82], [Evan84], and [Evan87]), Henry More's, Zöllner's, Randall's, and others' "fourth dimension" (see [Rand82] and [Schn13] p. 557 et seqq.), Little's "spectral reality" (see [Litt90] and [Litt94]), Harpur's "daimonic reality" (see [Harp95]), and Jung's "Realität der Psyche" (or "Wirklichkeit der Seele"), "archetypes", and "synchronicity" (see [Jung68], [Jung74], [Jung78], and [Jung73]; cf. also [Litt84]), suggested by some intrepid students of anomalous phenomena, are broadly similar or

In sum, the *traditional worldview* can be described as the affirmation of the four concepts of a *spiritual world,* a *soul,* a *Supreme Being,* and *miracles.* In contrast, the naturalistic *scientific worldview* essentially boils down to the denial of these four concepts and thus is properly characterised as the belief in *no spiritual world, no soul, no God, no miracles,* or, in more positive terms, a commitment to *this world, Darwinist materialism, the kingdom of man,* and *the magic of technoscience.* Even though I cannot and will not here undertake the interesting, but awe-inspiring judiciary task of pitting different worldviews against each other, I will in the next section argue that the basic scientific bias towards *naturalism* as well as the pseudo-religious faith in naturalistic science, often referred to as *scientism,* both are of little merit, inasmuch as naturalism is itself in glaring conflict with a large body of both well-known and less well-known evidence and, thus, the scientistic claim to excellency as *the* way to *truth* lacks a credible foundation.

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analogous to various elements of the traditional worldview. Although one may on good grounds be sceptical of man's capability to arrive at a grand unifying theory of these elusive phenomena and, additionally, the investigators and theorisers of the paranormal and anomalous often evince a stupendous naïveté, bias, and lack of insight when it comes to the religious or theological bearings of the studied occurrences, the results and conclusions arrived at nonetheless highlight the breakdown of scientific materialism that inevitably results, whenever anomalies are taken seriously rather than just ignored, denied, or condemned. An interesting theological discussion of different theories of the spiritistic-paranormal phenomena (viz. "die Betrugstheorie", "die Halluzinationstheorie", "die Theorien mechanischer, vitaler und physischer Kräfte", "die Theorie der „magischen Kraft"", "die spiritistische Theorie", "die Hypothese „vierdimensionaler Wesen"", "die dämonistische Theorie") can be found in [Schn13] p. 354 et seqq. Similarly, [Baer26] p. 11 et seqq. distinguishes four main parties amongst psychical researchers, to wit i) the spiritists, who interpret the studied phenomena as the outcome of the activities of spirits and/or demons, ii) the animists (or occultists), who believe that these result from subconscious, "occult", paranormal powers of the souls or the living, iii) the telepathists, who try to explain the phenomena in physicalist terms, and iv) the negativists (or sceptics), who believe all paranormal phenomena are to be explained by "natural" causes, such as fraud, hallucination, coincidence, etc. There are, of course, many possible intermediate positions between these four ideal types.

3.2 SCIENTISM AND THE DECLINE OF TRUTH

> *But then arises the doubt – can the mind of man, which has, as I fully believe, been developed from a mind as low as that possessed by the lowest animal, be trusted when it draws such grand conclusions?*
>
> *Charles Darwin*[1534]

Amongst professional philosophers, the question of how "truth" is to be defined is known as a notorious can of worms. The deep-seated common-sense "theory of correspondence", deriving its ancestry back to Aristotle, received its classical formulation – "veritas est adaequatio rei et intellectus" (truth is a correspondence of reality and intellect) – in scholastic philosophy, with St. Thomas Aquinas and, before him, Isaac Israeli. Various alternatives to this much-excoriated "copy theory of truth" have been suggested, each, however, marred by its own difficulties.[1535]

Ironically, the nominalist, naturalist drift of the modern scientific pursuit tends to undermine all truth claims, including those of science itself, as the belief, fundamental to modern science since the times of Galileo, that the reality that really counts is measurable and, thus, spatiotemporal *(metaphysical naturalism)* tends to render the phenomenal world we inhabit an insignificant, spooky side-effect of a foreign and possibly wholly unknowable noumenal world and, thus, all our conceptions about reality suspect – hence the modern preoccupation with the issues of epistemology.[1536] In particular, the present-day Darwinist anthropology, the corollary of the apotheosis of mechanist spatiotemporality, makes it *a priori* extremely implausible that the mental capacities of the human brain, believed to "emerge" inexplicably through the caprices of a materialistic-mechanical, entirely random evolutionary process, or some activity called 'science', instigated by this self-same lump of blubbery cerebral jelly, should be able to synthesise a truthful representation of a cosmos fundamentally alien to the sphere of survival-related skills to which the lump of jelly is held to be exclusively devoted. Thus, evolutionist beliefs inevitably lead to pragmatism, fictionalism, relativism, and scepticism with reference to the – scientific or other – pursuit of "truth" and are thus liable to backfire, detonating on science and evolutionism themselves.[1537]

As a corrective to such cognitive defeatism, many scientists and philosophers, in the last century notably those of the logico-positivist dispensation, have attempted to undergird scientific truth-claims by referring to a universal scientific method and through what today is commonly referred to by Herbert Butterfield's term 'whig history', i.e. the – often very naïvely valorising and self-validating – progressivist narratives of the history of science and technology, in which our present state of knowledge and culture is made the crowning achievement and point of history.[1538] To such methodolatrous and historiosophic mythopoeia[1539] was – and still is – occasionally joined a formidable, fretting and fuming rhetoric that tends to render science a kind of quasireligious pursuit, a paradoxical Church of anti-religion, engaged in a holy war against both established religion and all kinds of allegedly obscurantist forces ("scientism").[1540] This spirit, which is still found with

[1534] [DH83] p. 54. Although Darwin certainly meant this utterance as yet another dig at his pet bugbear God, the blurred reference of the sentence makes it look more like a Freudian slip of the pen, a parapraxis, in which he unawares reveals – and seemingly pensively retracts – the overwhelming absurdity and paradoxicality of the entire Darwinist congeries of speculative theorisation.

[1535] See [Lübc88] p. 485 et seqq. for a brief survey of the most important theories and some of the issues at hand.

[1536] This point is well made out by [Burt99].

[1537] Cf. [Baum88] p. 20 et seq., [Lewi96a] p. 20 et seqq., and [Jaki90] p. 124.

[1538] See [Butt31] and [Hall83].

[1539] Cf. [Fore83] and [Baue92].

[1540] There is something deeply paradoxical and at the same time very illuminating about the extensive reliance on – often extremely vehement – rhetoric within the "Enlightenment tradition", insofar as the advocates of the rationalistic-positivistic agenda of this tradition, claimed by them to be the paragon of objectivity and rationality, still need to make such heavy use of rhetoric, which by its very nature aims at the very opposite of objectivity and rationality, to wit the *magical* distortion of truth, to make the weaker argument stronger in order to promote one's own interests (cf. [Romi75]). Notably, Socratic-Platonic dialectics, which at times has been assumed to be at the root of the scientific-rationalistic tradition of the West – McLuhan, for example, famously contrasted the rhetoric-humanist culture of the American South with the dialectic-scientific culture of the North (see [Czit82] p. 167 et seqq.) – was largely intended as an antidote against

many writers on scientific topics, especially in the popular genre, such as, say, Sagan, Monod, Dawkins, or Dennett, and, indubitably, also with many practitioners of science, can be traced back at least to the Enlightenment[1541] and had its heyday in the 19th century with authors such as Comte, Draper, Dickson White, Lecky, and many others of their ilk.

The breakthrough of aggressively secularist naturalism as the ideology of science in the mid-19th century definitely marks the end of the period of science as a gentlemanly pastime pursued by the clergy and gentry to the greater glory of God and the beginning of the new era of institutionalised science and professional "scientists" and "engineers" – terms becoming current at about this time.[1542] For this new élite in the making, subordination to theologians and established religion was often unattractive or even odious, and the new secularism with its warfare myth, Darwinist cosmogony, and *persuasive definitions* of what constituted acceptable, "scientifically" acquired knowledge – as distinct from "metaphysics", "religion", "pseudo-science", etc. – obviously also served the purpose of legitimising its strivings for independence and social pre-eminence. Much like the political furores of the two last centuries, scientism, positivism, and, perhaps most conspicuously, Freemasonry, which, as we will see later, has strong liaisons with science and technology from its inception, also came to play the rôle of *ersatz religions* for many, filling out, albeit perforce ineptly, the more fundamental vacuum that resulted from the occlusion of the spiritual realm and the concomitant frustration of the elemental human impetus for communion with the divine.[1543]

Albeit largely a result of the positivist focus on science *per se,* the establishment of independent meta-scientific disciplines ('science studies'), notably the philosophy, history, and sociology of science, would eventually unsettle the positivist constructions fatally by:

- eroding the faith in the feasibility of defining a universally applicable scientific *method* and clear-cut, unbiased *demarcation criteria* for scientifically established knowledge[1544]
- showing how scientists actually proceed in a much more diversified, irrational, creative, rhetorically cunning, and interesting manner than can be captured by some simplistic formula, rationalist re-construction, or philosophical legislation[1545]
- providing a more realistic view of the history of science, where the often cataclysmic and spasmodic character of the changes in outlook – the "paradigm shifts" – and the complex web of theological, philosophical, occult, political, social, economical, and other factors and motives driving, influencing and shaping science are ferreted out[1546]

Sophistic-rhetoric truth obfuscation, which in Plato's analysis was the foremost progenitor of the tribulations and derailment of his times. The paramount rôle played by rhetoric in the West, apparently setting our culture apart from most other cultures, will also be one of its more problematic aspects. Insofar as this embroilment with rhetoric has become the predominating characteristic of the West, it can perhaps be argued, at least if we are to heed Plato, that Western culture should have been included amongst the examples of "sick societies" considered in [Edge92]. On the rhetoric of scientific discourse, see [Prel89], [Gros90] and [Lock92]. Cf. also [GK97] for a critical discussion of the prospects and problems of "the rhetoric of science" as an academic discipline. [Kell96] p. 119 contains an illuminating discussion of the rhetoric of neuroscience in the discourse on near-death experiences.

1541 See [Beck32] p. 105 et seqq. for an account of how the progressivist historiography was forged as a weapon against religion and tradition by the acerbically anti-Christian and anti-traditionalist *philosophes* of this time.

1542 See [Army65], [BenD71], and [Carl74]. William Whewell is usually credited with the coinage of the term "scientist" (in a text written in 1833) – see [Goli98] p. 67. Outside a military context, the term "engineer" – or in the early days "civil engineer" so as to distinguish it from the original military profession – started to be used in the 18th century and became common in the 19th (see [Nobl99] p. 79 et seq.).

1543 Cf. [Midg94] and [Nobl99] p. 68 et seqq. et passim.

1544 Kuhn's and Feyerabend's writings, in particular [Kuhn70] and [Feye93] (see also [LM74] and [Hans92a]), dealt the final *coup de grâce* to the former cult of the Method, as typified by the positivists' verificationism and Popper's falsificationism, and provided the impetus to the "strong programme" of the sociology of science. Rather oddly, the masterly and devastating [Feye93] is still almost as controversial as in the debates of the 70s, although by now its core arguments have been very widely, albeit at times only tacitly, assimilated by the cognoscenti. Ironically, Feyerabend's ideal of a more flexible and artistic science untrammelled by the inane dogmas of methodological theorising typical of modern scientism and positivist philosophy is strikingly similar to the spirit cultivated by the fathers of science, if now the founders and early members of the *Royal Society* are rightly so designated. See [Burn81] p. 19 et seqq. (in particular note 93 on p. 273, which also points out the fundamental difference in aims between the 'virtuosi' of early science and Feyerabend).

1545 See [Goli98] for an excellent survey and extensive references to the literature on the sociology of science. The

1546 See [OCCH96] for pointers into a very rich literature on these topics.

- suggesting that scientists typically act like "sleepwalkers" and do not correctly understand and appreciate the true nature and bearings of their pursuits and findings, in particular not in the long range.[1547]

Furthermore, quite contrary to the tenor of the historiography of "the warfare of science and theology"[1548], the emergence and early growth of modern science and technology in the Western, Christian world, taking off already at the outset of the Middle Ages[1549], are now widely held to have been conditioned by

1) various Judaeo-Christian attitudes and ideas on nature and creation including the notion of God as creator and law-giver, a realist conception of the created world, the developments in scholastic theology towards voluntarism, nominalism, and a view of the world as wholly contingent, an increasing appreciation of manual labour (notably in the monastic life of some holy orders) and human technical creativity (rooted in the view of man as *imago Dei,* the ordained sovereign of the creation, and 'co-creator'), and the dreams, largely millenarian in origin, of a (partial) restoration of the pre-lapsarian "principal perfections" of man (power over the creation, freedom from suffering, and immortality) to "the relief of man's estate", as Francis Bacon famously put it[1550]
2) the Neoplatonic-Hermetic-Kabbalistic undercurrents of Western thought and the so-called "occult sciences", magic, astrology, and alchemy[1551], not only crucial to the development of *scientia experimentalis*[1552], but zealously pursued by so many of the "fathers of science" from the astrologers Copernicus, Brahe, Kepler, and Galileo to the alchemists Boyle and Newton.[1553]

The breakdown in the scientistic-positivistic ideology resulting from such insights, exacerbated by the ever-growing pessimism as to the benevolence of 'technoscience' both amongst the intelligentsia and in the popular mind[1554], has created a vacuum, which neither the postmodernists' nihilist ironies and neo-Pyrrhonist piaffes on the horseback of Fries' trilemma – ironically the logical end-point of the one-sided rationalism of naturalistic scientism –, nor the lingering positivist nostalgia amongst some, mostly elderly, defenders of scientific right-thinking and many practitioners of science can adequately fill. Historically, fits of scepticism, such as the current one of postmodernism – pre-eminently prefigured by Nietzsche – tend to give expression to a vague feeling that something is fundamentally wrong with the present state of affairs of culture and intellectual life and thus to forebode the rise of something new at the expense of something old.[1555] By this reasoning, the scepticism of the Greek Sophistic Enlightenment of the 5th century B.C. portends the rise of

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[1547] See [Koes64].

[1548] [Dick1899]

[1549] See [Whit62] and [Gimp77] on the medieval "industrial revolution".

[1550] See footnote 1991 on p. 430 for some references to the literature. Of the many scientists, whose research has been driven or deeply influenced by mystico-religious motifs, we only need to mention Newton, Faraday, Maxwell, and Einstein to demonstrate the lack of substance and subtlety in the warfare idea. It should, however, be pointed out that although the Christian worldview provided the ambience, where the scientific agenda crystallised, some of the catalysts that made this crystallisation take place, such as nominalism, gnostic utopianism, and the Hermetic-magic assent to will-power, will be fundamentally at odds with Christian and Biblical ways of thought. See below p. 430 et seqq.

[1551] For references to the literature on these pursuits, see p. 375 below.

[1552] Notably, in the Middle Ages *experimentum* signified a magical recipe or technique provided in the extremely popular *libri secretorum*. In fact, Roger Bacon's *scientia experimentalis* was largely intended to test such magical recipes. See [Eamo94] p. 66. Cf. also [Hack95b]. By the same token, the terms "astrology" and "astronomy" were mostly used indiscriminately up to the Enlightenment, whereas "mathematician" commonly denoted an astrologer (see [Luck85] p. 309). Likewise "chemistry" and "alchemy" were synonyms until the early 18th century (see [PN01] p. 386). See footnote 2028 on p. 438 for more references.

[1553] See e.g. [Yate64] and [Goss88] for Giordano Bruno, [Ross68] for Francis Bacon, [Pach51], [Page58], [Page62], and [Week97] for Paracelsus, [Prin98] for Robert Boyle, [Page82] for J. B. van Helmont, [Coud99] for F. M. van Helmont, and [Popp35], [Fier53], [MR66], [West84a], [Dobb88a-b], [Dobb91], [Whit97], and [DJ95] for Newton. See also [MD88a].

[1554] See [Mitc94] for a survey of the field of the, by and large, pungently technopessimistic "philosophy of technology". [Olso82] provides a grand historical exposé of the appreciation of science through the ages.

[1555] Cf. [Gils99] p. 245 et seqq.

philosophy at the expense of the old pagan folk religion, Hellenistic scepticism – epitomised in Pilate's famous question, "What is truth?" – the rise of the Christian religion at the expense of Greek philosophy, and the modern scepticism, from the nominalist, *via moderna* sceptics of the 14th century, such as Nicholas of Autrecourt, to David Hume in the 18th, the rise of secular science and politics at the expense of Christian theology and theocracy.[1556]

Notably, the current truth scepticism is in stark contrast to the classical (pre-nominalist) Christian/Platonic truth optimism, according to which man, by virtue of his status as *imago Dei,* is capable – however imperfectly – of discovering or being illumined by the truth, i.e. the ideas, which, in the noetic/noumenal realm, constitute, as it were, the divine master plan, the archetypal *Logos,* of all that exists in the physical/phenomenal realm.[1557] In this view, these ideas or forms *ante res* residing in the *Logos* realm are at least as real as their reflections *in rebus* in the spatiotemporal domain, apprehended by us through our senses *post res.*[1558] According to the famous prologue of St. John's gospel, the *Logos,* the divine mind comprehending all the ideas, which is to say the entire master plan of creation, is in fact none else than Jesus Christ, through whom, thus, everything has been created. By the greatest conceivable paradox, this Logos has, according to St. John, taken on humble human flesh to the great benefit of humanity.[1559]

The predominant strains of modern Western philosophy have tended to be ostentatiously anti-metaphysical[1560], but, as was pointed out by Aldous Huxley, "It is impossible to live without a metaphysic. The choice that is given us is not between some kind of metaphysic and no metaphysic; it is always between a good metaphysic and a bad metaphysic, a metaphysic that corresponds reasonably closely with observed and inferred reality and one that doesn't."[1561] Thus, behind the thin, meretricious veil of the often flamboyant anti-metaphysical rhetoric and deconstructions, a naturalist metaphysic and an atheist theology almost unexceptionally lurk.

If we admit that the scientistic efforts to lay a new foundation for truth have lead nowhere, nay that they have largely been self-defeating, and that the belief in science as *the* royal road to truth cannot be upheld, one may want to consider other potential foundations of truth. Can classical metaphysics and theology be exploited in some more constructive way than as targets of vicious modernist and postmodernist annihilation attempts? Confronting the pragmatist conception of truth, which will be the ultimate consequence of scientism, and Comte's neo-Joachitic, positivist mythology of the three (theological, metaphysical, and

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1556 According to [Popk79] and [Burn81] p. 19 et seqq., Pyrrhonism was revived by some Catholic thinkers in the aftermath of the Reformation as a means to undermine the new-fangled Protestant arguments and, by the recourse to a fideist line of reasoning, lend support to the principle of authority inherent in the unbroken Apostolic tradition of Catholicism. However, the theory that the neo-Pyrrhonists were serious Catholics rather than dissimulating *libertins érudits* has been much criticised lately, e.g. by some of the contributors to [HW92].

1557 On *Logos,* see [Inge15], [Inge24] p. 32 et seqq., and [Kelb58].

1558 On the distinction between ahylic and enhylic forms – ideas *ante res* and *in rebus* – in the Platonic-Aristotelian tradition, see [Merl63] p. 16 et seq.

1559 Cf. also Chouraqui's rendition in [Chou89] of "Bereshit", the first words of *Gen. 1:1,* as "entête", "in his head", in preference to the traditional "in the beginning". If correct, this translation, which interestingly also corresponds to the way Philo understood (or, perhaps rather, misunderstood) the Greek *Genesis* text of *Septuagint* in *De opificio mundi,* dovetails with the Johannine conception of the *Logos* and, to boot, suggests an explanation to the much-debated occurrence in *Genesis* of two creation stories, which now can plausibly be construed as concerned with the noetic and material creation, respectively. Similar "Platonic" notions exist also outside the Jewish-Christian tradition, being part of, for example, the Egyptian "Memphite theology" of the Shabakah stone (the contents of which is believed to go back to the 3:rd dynasty!), according to which the god Ptah first shaped the world in his heart (i.e. in his mind) and thereupon brought it into being through his word (see [FFWJ49] p. 64 et seqq. and [Brea59] p. 43 et seqq.) and of the Zoroastrian scheme of world history put forward in *Bundahishn,* in which Ormuzd, during the first of the three (or four) phases of history, created everything on the invisible, noetic plane *(menog)* and only during the second period brought the world into material existence *(getig;* see [RS78] p. 188 et seq.). Also the concept of "primitive Platonism" – i.e. the widespread 'primitive' belief that every earthly phenomenon and natural kind of being is related to or reflects a certain archetype, typically conceived of as a deity, genius, guardian spirit or angel, 'elder brother', or the like and occasionally somehow associated with a star – discussed by [Tylo58] vol. II p. 328 et seqq. and [Glas67] p. 33 is obviously germane to this topic. Similarly, the Zoroastrian concept of the *fravashis* can, according to [Casa1909], be understood as the pre-existent ideas of all things and living beings.

1560 Cf. [Coyn95a] p. 120 et seqq.

1561 [Huxl46] p. 252. See also [Berg67], who attempts to show that, in spite of its anti-metaphysical rhetoric, logical positivism embedded its own metaphysics.

positivist) stages of human history, the German philosopher Max Scheler suggested his famous typology of knowledge, which accords to metaphysics and theology a paramount importance instead of just making them museum pieces in Comte's positivist church. Scheler distinguishes three different, but all fully legitimate *Wissensformen,* viz.

- practically useful *Leistungswissen* (or *Herrschaftswissen),* of which scientific and technological knowledge will be an important part, aiming at the control of the world
- *Wesenswissen* (or *Bildungswissen),* which is concerned with metaphysics and essences/ideas through contemplative *Wesensschau*, aiming at "höchste Personbildung durch Weisheit"[1562]
- *Erlösungswissen* (or *Heilswissen),* which pertains to the realm of the sacred and religion, serving, *inter alia,* soteriological ends.[1563]

There is definitely a point in recognising all these knowledge forms as important, but separate areas of concern, although the boundaries between them will be fuzzy and there will be very complex interactions and interdependencies between them. We may also note that they correspond very neatly with Kierkegaard's aforementioned "stadier paa livets vei".[1564]

Thus, rather than letting science become cryptometaphysics and *ersatz* religion, tasks for which it hardly will be very fit, we must, I believe, realise that science, at best, provides us only with tiny smithereens of knowledge and incomplete intimations about the world.[1565] As these will always be heavily coloured by their complex *Sitz im Leben,* both metaphysical and religious conceptions, *Wesens-* and *Erlösungswissen,* are perforce necessary to make sense of science, its theories, and facts and will, furthermore, decisively and complexly influence these in all kinds of ways as well as the way in which scientific research is carried out, just as science, indeed, impinges on our metaphysical and religious notions. The significance of metaphysical and religious suppositions is most clearly seen in contentious research areas, such as cosmology, evolutionary biology, artificial intelligence, cognitive science, conscience studies, depth and transpersonal psychology, comparative religion, biblical criticism, or parapsychology, but is really ubiquitous. In most scientific communities, there seems to be a deep-seated, but unfortunate tendency to stick tacitly and dogmatically to a certain set of metaphysical and religious (or, perhaps rather, cryptometaphysical and cryptoreligious) presuppositions, almost unexceptionally of a naturalist hue, rather than to entertain multiple competing sets hereof. In our contention, nothing is achieved by beating about the religio-metaphysical bush, making materialism, naturalism, and atheism a silent presupposition of scientific research, in particular not since naturalism rests on very shaky grounds or, rather, is *per se* untenable, as we shall now argue.

[1562] On Scheler's conception of what constitutes a "person", which in his terminology is different from a "consciousness", an "I", or a "human being", see [Lübe87] p. 98 et seqq.

[1563] See [Sche60] and [Sche63] p. 27 et seqq.

[1564] See above p. 302.

[1565] Cf. [Midg94].

One cannot prove reality by a syllogism; one can only point to it and invite the doubter to look.

Eric Voegelin[1566]

Could it be, then, that mechanistic science has been so successful merely because it has abstracted from the real world only those aspects of reality which are susceptible to mechanistic analysis, and ignored all the others?

John L. Randall[1567]

The assertion that our ego consists of protein molecules seems to me one of the most ridiculous ever made.

Kurt Gödel[1568]

Unsere Wissenschaften, bloß als solche, sind Spiele, welche der menschliche Geist, zeitvertreibend, sich ersinnt. Diese Spiele ersinnend, organisiert er nur seine Unwissenheit, ohne einer Erkenntnis des Wahren auch nur um ein Haar breit näher zu kommen. In einem gewissen Sinne entfernt er sich dadurch vielmehr von ihm, indem er bei diesem Geschäft sich über seine Unwissenheit bloß zerstreut, ihren Druck nicht mehr fühlt, sogar sie lieb gewinnt, weil sie – unendlich ist, weil das Spiel, das sie mit ihm treibt, immer mannigfaltiger, ergötzender, größer, berauschender wird. Wäre das Spiel mit unserer Unwissenheit nich unendlich und nicht so beschaffen, daß aus jeder seiner Wendungen ein neues Spiel entstünde: so würde es uns mit der Wissenschaft wie mit der Nürnberger Grillenspiel ergehen, das uns anekelt, so bald uns alle seine Gänge und mögliche Wendungen bekannt und geläufig sind.

Friedrich Heinrich Jacobi[1569]

Presently, the still popular picture, deeply rooted in Enlightenment and positivist progressivism, of a unified, coherent, purely naturalistic 'scientific worldview', which may now even be about to near perfection, seems slowly to be palling upon more and more well-informed observers – also outside the nihilist ranks of the postmodernism.[1570] To the present author at least, the current state of scientific knowledge appears more like an archipelago of diminutive, isolated islands of practically useful, but theoretically and interpretatively fragmented and, thus, fundamentally elusive as well as historically unstable and, at best, tentative *Leistungswissen,* floating on an ocean of murky metaphysical presumptions, suppositions, and pretensions, and instilling its sense of overwhelming peremptoriness on the current race of men and all kinds of rash, unwarranted, and specious notions and conclusion about cosmos, man, and the divine through the alluring impressiveness of its technical miracle-working, the technoscientific re-construction of our entire *Lebenswelt,* the formidability and influence of its institutions and printed output, and the skilful rhetoric of some of its proponents rather than through its efficacy in providing a satisfactorily coherent and unified conception of our fair world and the to-

[1566] [Voeg85] p. 579

[1567] [Rand77] p. 218

[1568] In a letter to Abraham Robinson cited in [Davi00] p. 136.

[1569] [Jaco26] p. 190 et seq.

[1570] See, for example, [Horg96], who argues that we are now drawing near the "end of science", when only intractable or marginal problems remain to be puzzled over, as intimated by the limitative character of some of the most important results of 20th century science (cf. [Sten89]), such as Gödel's *Unvollständigkeitstheorem* (impossibility of constructing a both consistent and complete formal system), Einstein's theory of special relativity (impossibility of travelling faster than light), Heisenberg's *Unschärferelation* (impossibility of determining both the position and momentum of a particle exactly), etc. As empirical science approaches its end, the more imaginative scientists, unwilling to spend their powers on petty matters, will have to resort to "ironic science", i.e. speculations over questions that science cannot answer, of which Horgan's book presents ample exemplification. Cf. also [Sten78], [Elve92], [Sare96], and [Barr99]. The opposite, traditionally progressivist view of science as "the endless frontier" (in Vannevar Bush's words; see [Zach97] p. 218 et seqq.) is advocated in [Clar73], [Holt93], [Kaku97], [CD97], [Madd99], [Berr99], in most of the contributions in [Grif99], and in many kindred works. [Rhod99] provides a historical anthology of technical predictions and visions. In [Serr82], Michel Serres argues that our present scraps of knowledge are but jetsam and flotsam floating on an unfathomable sea of chaotic multiplicity, which he aptly calls *noise*. The "end of science" debate partly parallels the "end of history" debate sparked off by Fukuyama (see [Fuku92] and [MWZ95]). See also footnote 1302 on p. 261 supra.

tality of human experience, as is so often light-heartedly taken for granted.[1571] When it comes to the issues that tend to concern us most as human beings, i.e. the realms of *Wesens-* and *Erlösungswissen* in Scheler's terminology, I for one have found myself in ever-increasing agreement with those who, like Jacobi already 200 years ago, submit that the *modern* scientific enterprise, at least in its more visible appearances, with its obsession with the surface aspects of reality, its dogmatic preference for the stance of metaphysical naturalism, and its consequent proclivity for an indifferent or hostile attitude towards anything that seems to undermine this stance is by and large more of a will-o'-the-wisp than a candle in the dark. [1572]

This to many preposterous contention, of course needs to be qualified and properly undergirded. To do so satisfactorily would, however, inevitably lead much too far off from the proper subject matter of this thesis.[1573] Suffice it to say, just to intimate the general drift of my thought in these matters, that the main problem with the modern 'scientific worldview', if we accept that such an animal exists and subsume under this designation the recent – explicit or, more frequently, implicit – attempts *guided by a naturalistic metaphysics* at a synthesis or 'grand view' of the sea of fragmented data and theories that constitute, as it were, the output of the pursuit of the sciences[1574], is, in my contention, that these 'grand views' are arrived at – and indeed only can be arrived at – by systematically ruling out of court, explaining away, or deforming – through, for instance, systematic reticence, intimidating denouncements, or linguistic sleight-of-hand, such as the use of vague catch phrases and the quick glossing over of difficulties[1575] – important, not to say absolutely fundamental, phenomena and characteristics of the world. Notably, these repressed anomalies include, just to name some of the most striking ones:

1) the conspicuous and most obtrusive fact that we – judging from the present writer's experience at least – actually are *conscious, willing, moral beings* rather than computers, machine-like robots, or zombies[1576]

2) the utterly complex and, to a human observer, often strikingly beautiful[1577] *order of being* that we can perceive everywhere in nature and, in particular, within the realm of the living, surpassing in subtlety, complexity, and quality all the feats of human ingenuity by far and hav-

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[1571] [Raju92] p. 91 argues that disregard for a unified outlook actually is constitutive of modern Western thinking and that the success of its sciences largely is to be accounted for by the Western scientist's neglect for philosophy and other sciences than his own, i.e. by his boldly starting out from "whatever he thinks to be hard facts and fundamental principles".

[1572] This tendency can be well characterised by Scheler's term "postulatorische Atheismus" (see [Sche76] p. 142).

[1573] Important recent critiques of philosophical naturalism include [Keil93], [WW93], and [CM00].

[1574] Typical ingredients of this stew presented in countless books – such as, just to pick one example, [RRCS98] – will be 1) some quantum physics (typically starring Bell's theorem and the Einstein-Rosen-Podolsky paradox) and some theory of relativity, spiced with speculations on black holes and an upcoming 'grand unified theory' of physics through superstrings or the like, 2) some 'big bang' cosmology, 3) some evolutionary biology, featuring the mysterious appearance of life from the primeval broth and the development of DNA-controlled life from one-celled organisms to man, orchestrated either according to the principles of orthodox neo-Darwinist gradualism or in rhythms of long-lasting static 'punctuated equilibria' and short stints of feverish progress, and 4) some neurophysiology, seasoned with musings on the 'emergence' of epiphenomenal consciousness through the evolution of the brain. There is both a more case-hardened variant of this narrative, focusing on the hardships and cruel arbitrariness of random Darwinian evolution, and a softer, usually professedly anti-reductionist strain – bitterly combated by the old guard of the case-hardened variety – evincing an appetency for quantum enigmas, complexity/chaos theory, emergence, connectionism (holograms!), process thinking, Gaia theory, and similar "holistic" concepts.

[1575] Some examples of such vague catch phrases that come to mind immediately are *self-organisation, emergence, natural selection,* and *survival of the fittest*. For a rather devastating appraisal of the idea of self-organisation, see [Over97]. By the same token, [Demb99b] wryly likens the concept of 'emergence' to alchemical transformation. Cf. also [Piep92] for a general discussion on the abuse of language.

[1576] Although no materialist theory of consciousness – be it epiphenomenalist, functionalist, reductive, eliminative, supervenient, emergent, behaviourist, identity-theoretical, computational, or what else these word-jugglers will come up with next – is so absurd that it does not have at least some dedicated votaries amongst the "philosophers of mind" (or should we rather call them "philosophers of mindlessness"), neither vague metaphors (such as the analogies between the brain and lyres, pianolas, telephone switches, computers, etc. suggested over the years; cf. [VE81], [Kass84], and [Bolt84a]), nor verbal conjuration, such as the talk of "pseudo-problem" or Plato's or Descartes' error in, for example, such influential works as [Ryle76] or [Dama94], can conceal the insuperable difficulties of materialism to deal with consciousness and *qualia* credibly. An excellent and extensive biography on the "philosophy of mind" (including many papers available on the web) is provided at http://www.u.arizona.edu/~chalmers/biblio.html. See also [Horg99], who punctures many of the exaggerated claims made about brain science, [Lewi80], who presents some puzzling clinical evidence about the irrelevance of the brain for human intelligence, and the remark in [Gaul02] p. 271 on the striking parallel between some kinds of brain research and the activities of the so-called phrenomesmerists in the mid-19th century.

[1577] Cf. [Duba99].

ing, at least to those of us unimpressed by three centuries or so of naturalist polemics, a strong, not to say compelling, appearance of being the outcome of masterly and intelligent design and engineering rather than of random processes[1578]

3) the considerable support lent to some kind of non-naturalistic metaphysics by *miracles* and *paranormal phenomena*[1579], which, by the way, seem to have acquired their odd name as well as their contentious status primarily by their inherent incongruity with metaphysical naturalism, although the taboos surrounding this area also have complex roots in age-old theological disputes[1580]

[1578] There has been much ado lately about the so-called "anthropic principle", i.e. the observation that the natural constants must be as they are in order to be observed and, thus, seem to be fine-tuned for (human) life. This principle is, of course, just a watered-down, secular variant of the time-honoured physico-teleological argument of natural theology, of which a classical formulation was provided by Archdeacon Paley ([Pale1830] p. 477 et seqq.). See [Cart74], [Dree90], [Core93], [BT96], [Lesl96], [Over97], [Dent98], [BDM00], and [Midg94] p. 165 et seqq. The reverse argument of dysteleology, invented by Haeckel, i.e. the claim that parts of living beings, such as the human appendix, are useless, dysfunctional, or remnants from an earlier stage of evolution *(vestigial organs* or *atavisms),* once upon a time much played up by those hostile to teleology and theology, has grown increasingly dubious, as our knowledge of the living realm has increased (see [JS98] p. 169 et seqq.).

[1579] [Wolm77] is a thorough, albeit a bit dated, handbook survey of parapsychology, its methods, results, and literature; [Whit76a], [Grat82], [EMRP86], [Irwi89a], [Brou91], [Stok97], and [Schm02] provide more concise overviews; [Mose74] is a still unsurpassed survey of the field from the mid-30s. Some useful encyclopaedias of the paranormal or various aspects of it are [Fodo66], [Spen77], [Shep84], [Cave74], [Boni76], [BB91], [Guil91], [Geor95b], [Bied76], and [Stor01] (non vidi Cavendish's *Man, Myth, and Magic),* whereas [Doug76], [Ingl92], [Ingl84], and [Belo93] are reasonable historical accounts of the field, also providing a bird's eye view of it. [Schn13], [Wies57], [Omez58], [Moor77a], [Kels77], [Mont81], [Benz83b], [Perr84], and [Hean84] consider the paranormal from a Christian point of view (see also footnote 1532 on p. 315 for some references to the literature on religious miracles). Useful bibliographical resources are [WD73], [Whit90b], [Clar78], [Clar84a], and [Kies86], to which I refer the interested reader for further guidance into the large literature and the numerous scholarly journals of this field. Albert L. Caillet's *Manuel bibliographique des sciences psychiques ou occultes,* Antiquariat Emil Hirsch's catalogue of Carl du Prel's library *Bibliotheca occulta et philosophica,* and Adam Crabtree's *Animal Magnetism, Early Hypnotism, and Psychical Research 1766-1925. An Annotated Bibliography* are important bibliographical standard works covering much of the older literature. In addition, various web resources related to the paranormal are listed at http://www.ed.ac.uk/~ejua35/parapsy.htm.

On the question of human survival of bodily death and the bearings of psychical research on this topic, which always has tended to be the cynosure of psychical research, there is a huge literature – see the recent (more or less) critical surveys of [Tenh], [Jaco79], [Bayl71], [Bayl73], [BM81], [Hick94], [Rogo77], [Rogo86], [Gaul83], [Thou84], [Lori84], [Kast95], [Berg88], [Wils89b], [Wils97], [Harp91], [Alme92], [Beck93], [RH93], [Rýzl96], [RH98], [Wils00], [Mors00b], and [Schw02], who by and large concur in affirming the strength of the empirical evidence in favour of survival and in rejecting the remonstrance of various detractors of the paranormal, but are less unanimous in their (mostly sensibly cautious and tentative) conclusions as to the general character of the post-mortem existence. Somewhat different Christian perspectives are provided in [Schn13], [Thur33], [Garr91], [Guar98a], [Mart98b], [Piep00], [Greg11] p. 177 et seqq. (Roman Catholic), [Rose98a] (Eastern Orthodox, severely criticised for Gnostic tendencies in [Azko_a-b]), [Schw81], [Kels82], [HM98], [Grot95], [Aban96], [Zale96], and [Sabo98] (Protestant). A valuable and thorough handbook of various theological, historical, anthropological, physical, biological, medical, and paranormal aspects of the survival question is provided in [Resc87]. Recent attempts to revive the formerly quite popular *super-ESP* hypothesis (see [Gaul61]) in order to explain (away) the phenomena that have a bearing on survival have been made by the psychical researcher William Roll (see [Roll89]) and the philosopher Stephen Braude (see [Brau96]). Although there is no denying that the interpretation of the various evidence for survival is fraught with problems, which if not properly understood will lead to premature conclusions, the *super-ESP* hypothesis, besides being encumbered with its own severe difficulties, seems – as has often been pointed out – to be somewhat self-defeating, insofar as it needs to ascribe such exceptional paranormal capabilities to the human psyche that post-mortem survival will appear a natural corollary. Cf. also the essays in [Door90] and the debates in [CM95] on the issues involved (see also [Cook96], [ABGO97], and [Cook97]). A collection of philosophical essays on immortality is provided in [Edwa92] as well as a valuable bibliographical essay, although, unfortunately, this essay, some of the papers, and the editor's own remarks are disfigured by a proclivity for the brand of cheap rationalistic sophistry and twisted mockery cherished by some philosophers in the analytical and "skeptical" traditions. Older contributions to the literature on survival of lasting importance include [Lomb88], [Myer61], [Flam20], [Matt87], [Bozz], [Murp45], [Pric53], [Hart59], and [Duca74]. Various religious and philosophical ideas on death and survival are surveyed in [Schn1883], [Alge1889] (see also the bibliography [Abbo1871]), [Pato21], [MacG92], [Lewi95], [CL95], [Cowa97], and [JM98]; cf. also [Wall95], [Fraz13], [Pett57], [Baar74], [Mbit69] p. 149 et seqq., [Jack70], [Ariè75], [Ariè81], and [Grof80]. [Gall84] provides some interesting Gallup polls on the beliefs concerning the after-life. Substantial portions of the annals of parapsychology and psychical research deal with the survival question. In particular, the now discontinued scholarly journal *Theta,* published by the *Psychical Research Foundation,* was devoted exclusively to the survival problem.

[1580] Egged on by their own hostility to the Catholic veneration of saints and belief in miracles – widely relied upon by Catholic apologists to buttress the Catholic faith and question the divine authority of Protestantism, which lacked these spectacular signs of divine approval –, the Reformers and many later Protestants claimed that the time of miracles had ended already in Antiquity, as soon as the Christian church had been firmly established *(cessationism).* Similar ideas had actually been broached already in the 14th century amongst the followers of William of Ockham, such as notably Nicole Oresme (see [Hans86] p. 134). But if the 'white' miracles performed by the saints are denied, the 'black' miracles associated with witchcraft, ceremonial magic, and the like will naturally dominate the picture of the supernormal, whereby the entire subject tended to become increasingly covered by a cloud of gloom and suspicion in Protestant Christendom, as still reflected in much Protestant literature on such topics, such as the erudite, but one-sided [AW93] and [AW96] or the manifesto of

4) the whole range of *altered states of consciousness,* including various mystical, contemplative, religious, visionary, near-death, out-of-the-body, and kindred experiences, which mostly tend to instil in those who experience them an impression of authenticity, veracity, and significance, thereby being conducive to a sense of reality at odds with metaphysical naturalism[1581]

relentless anti-Catholic cessationism [Warf72], the tone of voice of which is all but indistinguishable from that of today's 'skeptical' atheists. See [Burn81], [Walk88a], [Thom78], [Olso92], [Mull96], and [DP98] for interesting historical background materials on how the tides of opinion on the miraculous have changed over time and how the present ban on supernatural phenomena came to be.

All since the times of Spinoza, Hobbes, and the British deists (notably Woolston), whose arguments were summarised by Hume in his – in spite of its striking lack of originality – famous essay *Of Miracles* (see [Twey96]), there has been a steady flow of manifestos from "rationalists" and "sceptics", who by the recourse to arguments about the regularity of "the laws of nature" and suchlike assert that man is in the position to ascertain *a priori* what can happen and what cannot, without paying heed to empirical data or bothering to evaluate the strength of the available evidence. See [Wall1881] p. 1 et seqq. for one of many refutations of these awkwardly gauche and unpersuasive arguments, still to be heard over and over again from Hume's numerous modern admirers and epigones, in spite of their conspicuous speciousness. Cf. also [Tonq16], [Demb99a] p. 49 et seqq., [Swin70], [Larm96], [GH97b], and [Lewi96b].

Notably, the caustic and extremely biased publicity, disguised as "skepticism", which since the late 70s has flowed over-abundantly from the *Committee for the Scientific Investigation of Claims of the Paranormal (CSICOP,* see http://www.csicop.org), its magazine *The Skeptical Inquirer,* and the publishing house *Prometheus Press,* seems to have been oddly successful in instilling a general paraphobia amongst the uninformed (as well as some not so uninformed who should indeed know better), nay to have seriously curbed the growth of the subject of parapsychology as an academic discipline, despite the brashly populist, disingenuous, and entrenched character of their publications, the overwhelming amount of evidence in favour or the veracity of the paranormal phenomena amassed in the annals of psychical research over the years, the great public interest in the topic, the important philosophical, theological, and other implications of it (notably, of great interest to every practitioner of scientific experiments, as the "experimenter effects" will apply to all kinds of experiments; see [Rose66], [Rose94], [KT76], and [Shel98]), and the circumstance that most people, when asked whether they have had paranormal experiences, respond affirmatively (see [Radi97] p. 226, where two surveys are cited, in which 58% and 67%, respectively, of groups of American adults confirmed that they had experienced paranormal phenomena, and [Hans92c] p. 163, where two polls amongst magicians – often assumed to be universally sceptical of the paranormal – are cited, indicating a belief in paranormal phenomena amongst 82% and 72.3% of the subjects, respectively; cf. also [Hans90b]). It should be noted that there are very close links between *CSICOP* and the humanist movement, a quasi-religious organisation devoted to the propagation of humanistic atheism, sporting its own name-giving, wedding, and funeral ceremonies, pursuing all kinds of secularist political agendas, and promoting anti-religious, "skeptical", naturalistic, scientistic, and Darwinist ideas (see http://humanist.net).

In contrast to the kind of inquisitorial, hate- and fear-mongering "skeptical" dogmatism espoused by *CSICOP* and kindred organisations, based in quasi-religious beliefs and atheistic-materialistic philosophy, the scepticism of ancient times (e.g. as advocated in the writings of Sextus Empiricus) regarded dogmatism as its very adversary and fought it under the banner of such principles as *skepsis,* i.e. (unbiased) investigation, *epoche,* suspension of judgement, and *isostheneia,* the balancing of arguments so as to have them appear equally strong. A forceful criticism of the "skeptical" approach to the paranormal, including an exposé of the highly doubtful practices of *CSICOP,* is provided in [Ingl86] (see also [Rawl.81] and [Kamm82] on *CSICOP's* scandalous investigation of the so-called "Mars effect"). On the sociological aspects of the interactions between parapsychologists, debunkers, and the public, see [Wall79], [Maus79], [CP82], [PC84], [McCl84], and [Hess93]. Cf. also [Prin30], [MM80], [Irwi89b], [Hans92b], [Hans01b] p. 148 et seqq., [Hono94], [McCl94] p. 185 et seqq., and [Beck93] p. 121 et seqq.

[1581] Cf. [Piep95]. [Unde99] is a classical introductions to mysticism, [Ellw99] and [John95b] more recent and concise ones, whereas [Ferg76] provides a concise encyclopaedia of mysticism. Many eminent works on mystical theology authored by Roman Catholic theologians exist, such as [Devi1902], [Devi1903], [Zahn22], [Farg26], [Poul31], [Mage46], [Arin78], and [Garr]. Two standard works in being on Western Christian mysticism are Bernard McGinn's *The Presence of God* [McGi91] and Kurt Ruh's *Geschichte der abendländischen Mystik* [Ruh90]. Still valuable are also [Görr89] and [Ribe1895]. There is a sizeable number of web sites devoted to mysticism, altered states of consciousness, transpersonal psychology, and similar topics, albeit widely varying in character, tone of voice, depth, scholarliness, etc. For mysticism, http://www.clas.ufl.edu/users/gthursby/mys may provide one reasonable starting point.

On non-ordinary "states of consciousness", see [WU86], [KL81], [Ingl89], [Evan89a], [Arbm63], [Benz69b], and [Alva98]. [Jame79] and [Tart72] are the classical works on *religious experiences* and *altered states of consciousness (ASCs),* although it is only hesitatingly I adduce them here on account of their – and, in particular, the latter's – undue preoccupation with drug-taking experiments. Through the unfortunate influence of, in particular, Aldous Huxley and Timothy Leary, who in their widely read books promoted psychedelics as a kind of shortcut to mystical experience – though Freud (see [Jone94] p. 165), William James and others, such as the infamous occultist Aleister Crowley, who, according to [Webb76] p. 439, may actually have introduced Huxley to the use of mescaline, indeed anticipated them herein –, this entire field of study has become tarnished by drug experiments and drug propaganda, thus, in effect, also conducing greatly to the popularisation of the kind of noxious abuse – the truly diabolic counterfeit of true mysticism – that has ruined the lives of so many spiritually searching people. See also [AW96] p. 17 et seqq. et passim (cf. also [Koch_a]) for an evangelical-Christian critique of much of the current "dabbling" in altered states of consciousness, which without proper discernment and guidance may prove mentally and spiritually devastating. For all this and contrary to some popular misconceptions fomented by those hostile either to religion in general or just to its more spiritual expressions, genuine mysticism is of course not about drugs, odd enthusiastic sects, or mental aberrations (cf. [Zaeh61] and [Lher53]); on the contrary, evidence of a strong correlation between mental health and mystical experiences exists (see [Radi97] p. 227). Although at least some varieties of mystical experience will be quite common and may occasionally supervene spontaneously, it appears that the more profound forms of mystical spirituality will need to be cultivated by a long and arduous path of self-oblivion, serious moral and spiritual struggle, a strict discipline of prayer and contemplative exercise, and, possibly, some degree of asceticism and self-mortifica-

5) man's universal *religious, aesthetic,* and *moral inclinations* (St. Augustine's *cor inquietum* and the *semen religionis* and *synderesis* of Scholastic theology) and quest for communion with the divine through religious practices and spiritual exercises[1582]

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tion so as to, as it were, open the door for the workings of divine grace. Such austerities only few will be willing to take on themselves, particularly in our extraordinarily sensate-materialistic culture and age, so strongly characterised by the quest for thisworldly self-realisation, magnificent experiences, and immediate satisfaction, on which the counterfeit spirituality of the drug prophets feed.

[CLK00] provides an introduction – in handbook form – to the field of "anomalous experience", including hallucinations, synesthesia, lucid dreaming, and out-of-body, psi-related, alien abduction, past-life, near-death, anomalous healing, and mystical experiences. On out-of-the-body experiences (OOBEs), see also [Gree68], [Mitc81], [Blac83], [Gros76], [Alva82], and [Poyn01] (non vidi Irwin's *Flight of Mind)*, on near-death experiences (NDEs), [Mood75], [Mood78], [Ring80], [Ring85], [Ring92], [Sabo82], [Sabo98], [Lund82], [LW97a], [Zale87], [Rose98a], [Mors90], [Mors92], [Blac93], [Grot95], [Aban96], [Suth95d], [Kell96], [BY96], [FF97], [Nich00], and [RC99], which provides a fascinating account of the "mindsight" experienced by blind people during NDEs (and OOBEs). [Sabo98] includes the remarkable story of Pam Reynolds, whose very rich NDE – or perhaps we should rather say *ADE, After-Death Experience*, since Reynolds was in fact dead by all usual clinical criteria of death –, also featuring a considerable amount of veridic information from the OOBE phase of the NDE, happened during a meticulously documented "hypothermic cardiac arrest" – a very complex operation implicating a lowering of the body temperature to 60°F, stoppage of heartbeat and breathing, drainage of the blood from the brain, and a flattening of the brain waves, so that the EEG remained silent and no brain-stem response to sensory input could be registered for an extended period of time – and apparently defies the usual reductionist explanations by reference to some kind of residual brain activity, such as the would-be effects of hypoxia, endorphines, temporal lobe seizures, and suchlike. The research organisation *The International Association for Near-Death Studies (IANDS;* see http://www.iands.org), albeit sometimes cavilled at as a *New Age* stronghold, publishes the valuable scholarly periodical *Journal of Near-Death Studies* (formerly *Anabiosis).* At http://www.afterlife-psychical.org/lazarus/index.htm is available a useful bibliography of the NDE literature. Hypnagogic states are treated in [Mavr87], dreaming in [KD87]. On mesmerism and hypnotism, see [Gaul95], [Barb69], and [Crab93]. A classical historical survey of the phenomena of spirit possession is [Oest74], whereas [Klim87] and [Hast91] treat of channelling and [Huff82] investigates "the incubus experience" or "sleep paralysis". Germane to a proper understanding of many of these "anomalous experiences" is the phenomenon of *dissociation,* discussed in the vast literature on *multiple personality disorder (MPD),* recently renamed *dissociative identity disorder (DID),* about which there have been intense discussion and controversy during the 1980s and 1990s – some useful works on this topic are [Rogo87], [Brau95], [Hack95a], [MR96], [Crab97a], [Alli99], and the bibliography [GGC94]. On crystal-gazing and the ouija board, both widely used tools for inducing dissociation, see [Best65] and [Hunt85], respectively. On the dangers involved in such practices, see also [Raup20]. Cf. also [Crab97b], in which it is argued that modern man spends a large portion of his time in trance-like states. Finally, [Elle70] provides the classic history of modern psychiatry and the development of the concept of "the unconscious". On the latter concept, see also [Whyt62] and [Merl63]. At http://www.uwsp.edu/psych/dk/reading1.htm, an extensive list of relevant literature can be found.

Apart from such "anomalous experiences", [Berg90a] p. 59 et seqq. suggests that theologians should concern themselves with the "signals of transcendence" that, as "prototypical human gestures", are part of our everyday experience, but point beyond this reality, such as the human propensities for order, for play, for hope, for damnation of the impermissible, and for humour.

1582 At least since Cusanus, Pico, Montaigne, Postel, Herbert of Cherbury, and Jean Bodin, if not Philo, Justin, and Clemens Alexandrinus, or even Herodotus and Megasthenes (cf. [Naka92] p. 7 et seqq.), many have claimed or intimated, as 'perennialists' still do, that – despite all the *prima facie* diversity and the presence of all kinds of degenerate and derailed forms of religiosity and morality – there is a substantial concurrence, 'consensus gentium', or 'transcendental unity' between the different religions and cultures in:

i) basic moral principles, such as the Ten Commandments

ii) the phenomenology of religious and mystical practice and experience

iii) the general worldview as reflected in various fundamental beliefs about God, the spiritual realm, the afterlife, and general cosmology (see p. 312 above)

iv) certain recurrent themes of myth, such as
   - the creation and ordering of the Cosmos by God and, optionally, His angelic assistants (see [Spro91] and [Adam94])
   - the creation of Paradise, the wonderful garden, with which will often be associated various important trees, such as the tree of life, the tree of knowledge, and the world tree, as well as a spring and/or four paradisaical rivers and the notion of the world mountain, at times replacing the world tree, at times providing its foundation (see [Hein95] p. 58 et seqq.)
   - the creation of primordial man, often out of clay, followed by the Golden Age of his sojourn in Paradise (see [Hein95] and [Pett57] p. 18 et seqq.; cf. also [Benz55])
   - the Fall of Man through some kind of primordial sin, error, or mistake (see [Tenn68])
   - the increasing corruption of the world, as marked by the appearance of the giants (see [Step89])
   - the Flood (see [Riem25], [Dund88], and [Cohn99])
   - the Tower of Babel (see [Bors95])
   - various dragon fights (see [Font80]), etc.

I will not here go into the difficult and somewhat sore issue of to what extent this surmise has been confirmed or contradicted by modern comparative and phenomenological studies of religion – see, for example, [Schu93] and [Zaeh62] for two diametrically opposite views. For an account of the history of the field of comparative religion, in particular in its academic manifestations since the late 19th century, see [Shar75]; on the early history, see [Pina29] vol. I and [Hard1901]. See also [Pina29], [Jame61a], [Pett72], [Elia74], [Clar86], [Pade94], and [PR00]. Christian viewpoints on the subject are found in [Ande71] and [Ches1908] p. 218 et seqq.

Indeed, these somewhat disparate categories of phenomena are anomalous only from the point of view of naturalism, but will fit in quite neatly in most other kinds of metaphysics. In fact, they have most probably been of paramount importance for the formation and preservation of the non-naturalist metaphysics, which pervades not only the traditions of higher philosophy and theology all over the world, but is omnipresent in folk beliefs and fundamental religious concepts concerning spirits, souls, life after death, etc.[1583] Only by bracketing a large part of reality, naturalism has been able to gain its present primacy. However, it goes without saying that we never can arrive at a truthful understanding of reality by ignoring or prohibiting discussion of parts of it, but will, in case we choose to pursue such a path of dogmatism, inevitably end up in error, falsehood, and (self-)deception, in short in what amounts to the construction of a "dream-story".[1584] Thus, we must, I submit, try to bring our body of scientific theory into harmony with also these kinds of ignored or repressed, but obviously highly significant phenomena, which hardly can be done without renouncing metaphysical naturalism and scrapping or revising much of the theory derived from it as incapable of providing a truthful representation of reality. In particular, this must, I believe, happen to what is, after the demise of the Newtonian clockwork universe and the golf ball atomism variety of materialism[1585], the bedrock of present-day scientific naturalism, viz. neo-Darwinist evolutionism. If my exposition in the following section, which will deal with this topic, may seem polemical, it has deliberately been made so in order to, if possible, awaken the reader from the dumbing thrall of Darwinist indoctrination and inspire him to investigate the evidence for himself. Anyone who does so with an open mind must needs, I contend, reach the conclusion that Darwinism is but a phantasmagoria, from which we must free ourselves in order to regain reality. May the scales fall!

[1583] See [McCl94].

[1584] See [Voeg77].

[1585] Cf. [Herb85] and [Smit95] for some thought-provoking reflections on the philosophical dimensions of modern physics.

> *The Darwinian claim that all the adaptive design of nature has resulted from a random search, a mechanism unable to find the best solution in a game of checkers, is one of the most daring claims in the history of science.*
>
> *Michael Denton*[1586]
>
> *Kritiker i våra dagar ha ofta frågat sig huru en så svagt grundad hypotes som Darwins kunde med ett slag erövra största delen av samtidens vetenskapliga opinion.*
>
> *Erik Nordenskiöld*[1587]
>
> *The operational success and doctrinal aggressiveness of American neo-Darwinists enabled them to establish a near-monopoly over academic jobs, research funding, and scientific journals that persists to this day.*
>
> *Jonathan Wells*[1588]
>
> *Evolution, whatever scientists may say about it, will clearly continue to be accepted for a long time to come owing to its association with political and quasi-religious creeds.*
>
> *Robert E. D. Clark*[1589]
>
> *The determination to exclude Christianity plays a part in the arguments, but it is only a reflection of a far more significant fact: Darwinism itself has become a religion.*
>
> *Norman Macbeth*[1590]

The historian Carl Becker once remarked that whereas science today enacts a rôle similar to that played by philosophy in medieval scholasticism, history has now taken on the rôle of theology.[1591] Like all world-

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[1586] [Dent85] p. 324

[1587] [Nord25] vol. III p. 258

[1588] [Well00] p. 192

[1589] [Clar58] p. 185

[1590] [Macb71] p. 126. This author lists five "traits" in support of his thesis that Darwinism is a religion: 1) the Darwinist attitude of "all who are not with me are against me" 2) reproof of the fainthearted 3) missionary zeal 4) perfect faith (i.e. the claim of being the answer to all riddles) 5) millenarianism. Cf. also [Holb87] p. 27 et seqq., [Gree81], and [Midg85].

[1591] [Beck32] p. 17. Although we will here pay attention to the Darwinist brand of historical speculation only, all attempts at historical reconstruction of the periods that precede the era of reasonably reliable written records, which in our culture by and large can be said to start with the Bible and the early Greek historians and logographers, will, at best, be extremely rickety and tenuous. This can be seen from the very messy and contentious character of the historiography of the ancient world before, say, 600-500 B.C. Consequently, the usual chronology of this early period has repeatedly been subjected to scathing criticisms and brave revision attempts, typically altering the dates and the order of a pick of events and epochs, while eliminating others altogether – by preference the inept 'Dark Ages' of Greece and other cultures (see [Crow00] for a concise survey of some such attempts, of which one of the more notable is [Jame93]).

Proceeding further back into geological time, one does by no means need to be a young earth creationist or a supporter of "Flood geology" to become concerned about the soundness of the prevalent dogma of radiometric dating methods, as codified in [Dalr91] and irately defended in [Henk], upon the perusal of such a tightly argued and learned deconstruction hereof as that of [Wood99], who, in conclusion, delivers this harsh, but apparently not unwarranted verdict on geochronology (p. 96): "The conundrum of discrepant results and special pleadings deprive isotopic dating of all credibility. It remains doubtful if there exists any other field of science where data could be so selectively manipulated at will." Notably, [Milt97] and [CT96], neither of whom is a creationist, make a similar case. Cf. also [VSC00], [Crem01], and [Hans01b] p. 328 et seq. and p. 338 et seq.

At the cosmogonic time-scale, the now widely accepted history of the universe according to the *Big Bang,* which event some luminaries in this field are confident they can describe in excruciating detail down to the most minute fraction of a second (in fact 10^{-43} s), has repeatedly been challenged by various competent dissidents (such as Hoyle, Wickramasinghe, Arp, Reber, Marmet, Alfvén, Peratt, Lerner, Narlikar, Segal, and LaViolette), who seem to be able not only to give more or less plausible alternative interpretations of the astronomical data (notably the spectral red shifts interpreted as Doppler effects in the *Big Bang* theory and the cosmic background radiation supposed to have emerged subsequently to the *Bang* proper), but also to present a variety of counterevidence against the *Bang.* [Mitc97] provides a concise, popular (non-mathematical) survey of some of the issues with the *Big Bang* theory; see also [Dree90], [Arp87], [Arp98], [HBN00], [Lern92], [Mitc95b], [Mitc95b], the dauntless [LaVi95], and http://redshift.vif.com, the web site of *Apeiron,* a journal (and publishing house) for alternative theories in physics and cosmology. In addition, [Krag96] provides a readable history of the controversy over modern cosmology. In [Berl98], David Berlinski aptly points out, "Like Darwin's theory of evolution, Big Bang cosmology has undergone

views, also present-day "scientific materialism" indeed rests on such a kind of theology – which in this particular case, however, perhaps rather is to be called an *atheology* or even an *anti-theology* – in the form of a cosmogonic myth, which emplots the history of the world and mankind and provides an explanation of the origin of cosmos and man, although, in contrast to the traditional cosmogonies, this one does so from purely naturalistic metaphysical presuppositions.[1592] This cosmogonic myth is the terrible spook of neo-Darwinist evolutionism, at whose beck and call is, apprehensively and timorously, the entire modern world, though otherwise so doughtily prone to incredulity, cynicism, and crackdowns on anything that has come down from previous times. Albeit in essence little more than a collection of loose, threadbare hypotheses, rash conclusions, catchpenny bromides, and unwarranted generalisations, fraught with both striking logical inconsistencies and the most glaring inadequacy in coping with what relevant *factual* information we have in these matters from such diverse branches of science as palaeontology, geology, embryology, microbiology, genetics, etc., Darwinism has been inculcated on the present generation of Western men as a matter of 'scientific fact' through what can only be characterised as an intoxicating mixture of mesmerising rhetoric and belligerent brainwashing, buttressed by the total abrogation of all normal critical standards and the systematic use of flawed, fraudulent, or contorted evidence[1593] – and this in spite of its potentially disturbing, not to say patently brutalising, effects on human mores, society, and culture, well illustrated by the evils of the history of the 20th century.[1594] That there is and always has been well-articulated and well-argued opposition to Darwinism amongst professional biologists and other well-informed and competent observers (during the last few years gaining considerably in strength through the appearance of the school of *intelligent design*[1595]), all since it was broached by Darwin and

that curious social process in which a scientific theory is promoted to a secular myth. The two theories serve as points of certainty in an intellectual culture that is otherwise disposed to give the benefit of the doubt to doubt itself." Arguably, at least some of the popularity of the *Big Bang* hypothesis may be accounted for by its usefulness for the same kind of progressivist-evolutionary historiosophy, to which Darwinism provides another corner stone – as well as its capability of supporting a number of widely cherished, but quite different interpretations of the world, ranging from hardcore naturalistic pan-evolutionism over deism and *New Age* 'soft evolutionism' to Christian theism. Oddly, the *Big Bang* seems to be deeply unpopular only with (some) die-hard 'skeptical' atheists, Marxists, young earth creationists, theosophers, and adepts of Indian religions – indeed a somewhat unlikely coalition! Aside from the shaky constructions coming out of the attempts to track down the history of the pre-literate, geological, and cosmological ages, not even such directly testable and apparently well-proven theories of physics as quantum mechanics or relativity lack educated critics (see, for example, [Jaki00] p. 168 et seq. and the *Apeiron* web site).

1592 [Adam94] provides an encyclopædia, [Spro91] a compilation of creation stories and cosmogonic myths from all over the world. It should be noted that whereas the modern naturalistic cosmogony is at odds with the creationism of the Abrahamitic religions and the *Urmonotheismus* Wilhelm Schmidt considered distinctive of the primeval culture (see footnote 1528 on p. 314 above), there is a certain affinity between it and the ancient Indo-European chaos myths, such as, for instance, those recounted by Hesiodus or Snorre, who let the first beings emerge out of a primordial *Chaos* or *Ginnungagap* by a sudden, inexplicable *generatio spontanea* rather than by a divine act of creation, which brings into being a design thought out beforehand. This affinity in basic thought patterns is hardly surprising, as modernity – and with it modern science – largely emerged from the revival of various ideas and attitudes of ancient paganism, philosophy, and 'science'. See also [Land91], in which the folkloristic traits of the paleoanthropological narratives of man's descent from the apes are brought to notice.

1593 See [Well00], Jonathan Wells' amazing exposition of such "icons of evolution".

1594 The troublesome impact of Darwinism and later neo-Darwinism, "la gangrène néo-darwinienne, maladie incurable" as the great zoologist Grassé called it some years ago ([Gras80] p. 150), and its motley progeny, such as eugenics, racial biology, social Darwinism, sociobiology, Haeckel's monism, etc., on about every aspect of modernity, including philosophy, theology, sociology, psychology, popular morality, and the political ideologies (most conspicuously on national socialism, but clearly discernible in most varieties of radicalism and socialism, such as Marxism, fascism, and social democracy, as well as in various kinds of chauvinist nationalism and liberalism of the laissez-faire hue) is examined in [Clar58] p. 96 et seqq., [Himm68] p. 379 et seqq., [Gree63], [Benz65], [Bowl89a] p. 218 et seqq., p. 282 et seqq. et passim, [Vogt97], [Hawk97], [Bann79], [Hofs55], [Jone80], [Gras80], [Midg85], [Degl91], [Kaye97], [Caud97], [Gasm71], [Gasm98], [Beck88], [Braw95] p. 79 et seqq., and [Weik99]. The evils to come out of the Darwinian outlook with its aptitude for the legitimisation of all kinds of violent, cruel, and heartless behaviour against those disliked or thought to be unfit, inferior, or just in the way, be it the rich, the poor, the weak, the sickly, the mentally retarded, or people of another race, denomination, or nation, were astutely prophesied already by Darwin's teacher Adam Sedgwick, who upon the perusal of *On the Origin of Species* remarked that if Darwin's teachings were to be accepted, humanity "would suffer a damage that might brutalize it, and sink the human race into a lower grade of degradation than any into which it has fallen since its written records tell us of its history" (quoted from [Clar58] p. 96). Unfortunately, the trite observation that "ideas have consequences", the title of Weaver's famous book [Weav84], will seldom give pause to intellectuals bedazzled by the theoretical juggling of concepts and ideas.

1595 [John93] provides an excellent introduction to the thought of this school. The web pages of the *Access Research Network*, http://www.arn.org, hold various materials about the intelligent design agenda. A good place to start if one wants to survey the part of the evolution debate that is pursued on the web is http://www-acs.ucsd.edu/%7Eidea/links.htm, where a large number of web sites promoting different points of view are listed together with a rating. Of special merit are the discussions entertained at the http://www.metalist.org site, where leading proponents of both intelligent design and neo-Darwinism (as well as various other views) debate their ideas. The school of "intelligent design" should not, as sometimes is done – mostly, however, for rather obvious polemical reasons –, be confounded with "creation science", also referred to as "scientific creationism" or, somewhat more broadly, as "young earth creationism", the

Wallace in 1859[1596], tends to become entirely obscured by the inundation of modern Western societies by Darwinist propaganda, in particular so in Europe, whereas in the United States, where mistrust in the powers that be and their hidden agendas is an integral part of the national temper and religion and spirituality have been able to retain their vitality and grip to a much larger degree than in the old world, the resistance has been more vigorous. But to many, or, perhaps rather, most, well-educated people, at least in the Western world, Darwin-

advocates of which support a strictly literalist interpretation of the days of the Genesis creation story – see [Numb93] for a historical account of this latter movement, which emerged out of American Seventh-Day Adventism in the 1920s and started to gain wind only in the late 1950s. Notably, the intelligent design school does not promote any specific theory on how living beings came into existence and developed into their present exuberance, but leaves it as the mystery it arguably is (although some of its adherents may be more outspoken on this topic). Instead, it attempts to show 1) that "the fact of Darwinist evolution" is not a "fact" at all, but a philosophically motivated theory (cf. also [BH94]), which is *not* supported by only tenuous empirical proof, as can be expected from the naturally speculative character of such a genre as the historiography of life, but actually is largely at odds with the existing factual evidence and, thus, in principle, untenable, and 2) that living beings contain innumerable features and structures that would count as the result of "intelligent design" in the acceptation of this phrase used, for instance, in jurisprudence. In [Demb98b], the mathematician and philosopher William Dembski, one of the leading proponents of this school, defines the term "intelligent design" formally and rigorously on the basis of the concept "specified complexity" (cf. also [Demb99a] p. 153 et seqq.). [Bowl92] surveys various (older) non-Darwinist evolutionary theories, including Lamarckism, orthogenesis (i.e. evolution directed by some kind of inner impulse), 'theistic evolutionism', and the 'mutation theory' (a kind of saltationist macromutationalism). Cf. also [Løvt87].

1596 In fact, Darwin was forced by the blistering criticisms levied against his speculations to fundamentally revise his own theories on natural selection through the introduction of the *pangenesis* theory, eventually taking a stance not far from that of Larmarck's. Wallace, who became a spiritualist, soon came to hold that natural selection was unable to account for things such as man's artistic, mathematical, and musical faculties (see [Macb71] p. 103). Indeed, there was well-grounded opposition to the Romanticist predecessors of Darwinism as well, as exemplified by Jacobi's famous attack on Schelling's evolutionary ideas in 1812 (see [Jaco26] p. 205 et seqq.) in defence of the fundamental truism that the more perfect *(das Vollkommenere)* will not spontaneously evolve from the more imperfect *(das Unvollkommenere)* – i.e. the principle that no effect can be greater than its cause, well expressed in the maxim "quod non habet, dare non potest". By the same token, Kant in *Kritik der Urteilskraft* pointed out that the need for design and teleological explanation will not be disposed of by positing a mechanistic process of evolutionary development where one species is transformed into another through some complicated mechanism, but only be pushed backwards (see [Kant95] §80 p. 328 et seqq.). Oddly, similar objections may have been made already by Aristotle *(Metaph. XII.VII.10-11)* against Speusippus and some Pythagoreans, who advocated what has been interpreted as some kind of rudimentary evolutionary theory! Cf. also [Brüg71] and [Love64] p. 321 et seqq.

The Romantic, organismic brand of evolutionism of German *Naturphilosophie*, prefiguring Darwin's dourly mechanistic theory of evolution through natural selection, largely arose as a temporalisation of the Kabbalist notions of God as the *ens manifestativum sui* (notably present in the Swabian tradition of the Christian Cabala and, in particular, in the theosophy of Jacob Behmen, the *philosophus teutonicus)* and *tikkun,* restoration or re-integration, the Platonic *anima mundi* concept, and the "great chain of being" of Neoplatonic emanationism. See [Benz83a], [Wals83], [Coud99] p. 347 et seqq., [Viat28], [Hane98a] p. 462 et seqq., [Benz58], [Dan97], [Tuve82], [Wals92], and [Love64]. The esoteric-Platonic undercurrent of Western thought, out of which the evolutionary theories originally sprang, has had a complex and wide-ranging influence on the development of science (see p. 319 above for some other examples). Today, it is continued by the much-scolded *New Age* movement (see [Hane98b] and [Hane98a] p. 62 et seqq. et passim), which, at least in its more scholarly appearances, largely is to be understood as an attempt to reconcile the esoteric traditions – which can be traced back to ancient Neoplatonism and Hermeticism via Renaissance Hermeticism and Platonism – with modern science and evolutionism, much like the 19th century occultism, which was its ancestor. Cf. also [GTS68] for a pick of essays on the "forerunners of Darwin" and [Gree59] for a study of the gradual development of the Newtonian conception of nature as "a law-bound system of matter and motion" into its Darwinist ramifications. In [Bowl88] and [Bowl92], the historian Peter Bowler sets out to show that Darwinism (i.e. the mechanistic evolutionary theory founded on the concept of *natural selection)* did not become predominant in biology until the rise of neo-Darwinism in the 1920s-40s and that Darwin's early impact, ironically, consisted mainly in the popularisation of non-Darwinian evolutionism rather than evolution through *natural selection,* contrary to what is often assumed in popular accounts and the heroising historiography of "the Darwin industry". However, Darwin's own espousal of the *pangenesis* theory, which assumes the inheritance of acquired characteristics, makes the borderline between Darwinian and non-Darwinian evolutionism very fuzzy. Cf. also [Hull73] for a survey of the critical reactions to Darwin's speculations from his contemporaries amongst the biological expertise.

The incapability of the Darwinist claims to withstand critical assessment has been demonstrated repeatedly over the years, for example in the writings of the lawyers Macbeth (see [Macb71]), Bird (see [Bird89]), and Johnson (see [John93], [John95a], and [John98b]). [Hard53], [Hard67], [Hard68], [Leth69], and [Rand77] enlarge on the interesting topic of the interrelationship between (non-Darwinist) biology and parapsychology. An early and relentless critic of Darwin and Darwinism was Samuel Butler, whose scintillating writings on the issue, such as [Butl22], made a strong impact on his contemporaries and still are well worth reading. Other significant works critical of the neo-Darwinist brand of evolutionism or important aspects of it are [Dewa57], [Clar58], [MK85], [Gras73], [Spil74], [Wild75], [Illi80], [Gree81], [Wild81], [Shel81], [Shel95q], [Cohe84], [HS84], [Dent85], [Løvt87], [Sund98], [Wess93], [DKT93], [ReMi93], [Meba95], [CT96], [Crem01], [Milt97], [Demb98a], [Booh98], [Broo98], [JS98] (the best overall treatment), [Spet98], [Behe98], [Dent98], [Demb99a], [BDM00], [Well00], and [DK01]. As a matter of fact, [McIv92] contains capsule summaries (unfortunately written in the big-headed, condescending style typical of the "skeptical" cast of mind) of 1852 anti-evolutionist works published up to 1988, although the bulk of these will be short religious tracts and some of them are rather dubiously classified as "anti-evolution" literature, whereas many of the more significant works are left out. Cf. also [Hein68], [Hein72], and [BD92] for a discussion of *vitalism* in biology and elsewhere and [Gils84] for an attempt to chart the importance of final causes in "biophilosophy". [LH35], the pugilistic correspondence between Arnold Lunn and J. B. S. Haldane on evolution and theism, also remains eminently readable.

ism has by constant inurement gained the same self-evident status as, for example, geocentricism enjoyed before Copernicus, and no longer are educated men generally able to discern the absurdity of the presuppositions on which this theory rests.

Nonetheless, the more we learn about life and its stunning complexity and its intricate mechanisms and structures, as exemplified by the 'irreducibly complex' molecular micro-machines of the cell[1597] or the masterly feats of control programming performed in the 'language' of the genetic code, the more Darwin's projection of Adam Smith's and Malthus' simplistic economical theories, Manchester liberalism, and Enlightenment progressivism (or rather, a very harsh mixture of these) upon nature[1598], the fantastic old nihilist wives' tale of matter, which self-organises itself into the most elaborate organic structures, such as eyes, ears, wings, hands, etc. through the blind carnage of *natural selection,* and the neo-Darwinists' brusquely categorical announcements about the greatest mysteries, told with a characteristically intimidating and allegiance-demanding fervour, will strain belief beyond all measure, at least amongst the more incredulous of us and especially amongst those of us familiar with the extreme fragility of complex control systems, such as computer programmes.[1599] In the

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[1597] See [Behe98].

[1598] This was widely noted by the more perceptive of Darwin's own contemporaries, such as Peirce (see [Peir55] p. 363 et seq.) and Marx (see [Kaye97] p. 7; cf. also [Colp74]). It was a matter of concern to radicals and socialists inimical to market capitalism, such as Marx, for whom the attraction of Darwinism instead lay in its incompatibility with religion, its materialist foundations and implications, and its general progressivism. Cf. also [Ruse96], [Schw86], and [Bowl88] p. 34 et seqq., who, however, unwisely downplays the significance of this observation. The predilection for Lamarckism amongst latter-day Soviet communists is well known (see [Bowl89a] p. 266 et seqq.). Interestingly, [Sand] points out that it is not very astonishing that alternative theories of evolution, such as the "neutral theory" proposed by Mooto Kimura and the ideas on coexistence in groups advocated by Kinji Imanishi, have emerged in Japan with its corporativistic mind-set, so fundamentally inimical to the individualistic struggle metaphor typical of Western capitalism.

[1599] Something of the vigour of the current anti-Darwinism can be sensed by the following somewhat lengthy quotation from a review article [John99b] by Prof. Philip Johnson, a leading proponent of the school of *intelligent design*. Besides pinpointing some conspicuous deficiencies in the Darwinist dogma, this excerpt also well illustrates how intimately thought on software creation, world creation, and life creation are interwoven in the modern mind and, thus, well bears out the interesting rôle computing, information theory, statistical considerations, and software construction tend to take on in metaphysical thought-experiments (cf. also [Spet98], [ReMi93], [Cohe84], and [Demb98b]),

"We are entitled to ask for experimental confirmation of so marvelous a tale, and of course it won't be forthcoming. The standard examples of Darwinism-in-action involve only cyclical variations in fundamentally stable populations of peppered moths and finches. Random mutation is typically an information-reducing entity, even if there are rare exceptions. Some mutations are fitness enhancing, to be sure, as when a bacterium becomes resistant to an antibiotic, but this does not necessarily mean that they increase genetic information. Lee Spetner's book *Not By Chance* (Judaica Press 1998) explains that a mutations (sic!) that causes a bacterium to become resistant to streptomycin, for example, is information-reducing. It disables a site on a ribosome where the drug normally attaches, and so the drug molecule can no longer do its damage to the bacterium. By analogy, a random change in an elaborate computer programme might on rare occasions improve the computer's performance; if it disabled some feature that was causing trouble in a particular environment. But that is not how computers and their software are built up in the first place. In fact biologists believe in the creative power of the mutation/selection mechanism for exactly the same reason that prebiological chemists like de Duve believe that chemical reactions can create genetic information. They are philosophical materialists, and identify science with that philosophy, and so they assume that nothing other than law and chance was available to do all the creating that had to be done.

One reason that many scientists think that "materialism" and "science" are just two words for the same thing is that they assume that the only alternative to law and chance is miracle, by which they mean a cosmic magician's arbitrary interference with the stately order of natural law. But why should they assume that? If we go back to the computer and its software as an example, it is evident that intelligent design is also part of the natural order. A computer does not operate by magic, nor does it contravene the laws of physics and chemistry. Its operations are within the laws and as predictable as other systems which scientists study, even though a computer does not come into existence until an intelligent entity designs its hardware and software. If genetic information is comparable to software, it must be designed by an entity with the capability of a software designer. That's just a fact, and science doesn't progress by denying facts in order to take refuge in comfortable philosophical assumptions.

Even the most unyielding Darwinists seem to have some sense that their biological mechanism is inadequate. In his 1998 book *Unweaving the Rainbow,* Richard Dawkins castigates his rival Stephen Jay Gould for misleading the public by using "bad poetry" to describe evolution. Yet Dawkins himself employs dubious metaphors to make his points, especially when he tries to illustrate the power of natural selection by comparing it to a computer running a program. He does this most famously in Chapter Three of *The Blind Watchmaker,* where he explains how a computer can write a text of Shakespeare by selecting the right letters from a random array. Many lesser science writers have followed his example. …

When used to demonstrate what natural selection can do, the analogy to a computer is either a howler or a fraud. I don't say that in order to complain, but to point out why Darwinists have to resort to such bad poetry to defend their system. The reason is that, once the problem of biological evolution is framed as "information creation" rather than "variation within the type," the inadequacy of the peppered moth and finch beak examples is glaringly obvious. Computers with intelligently designed programs become the basis of thought-experiments, because the Darwinists at some level understand that their mechanism cannot do the necessary information-creating …"

compass of this short introduction, it will be neither possible, nor very apposite to repeat in detail the complicated and, ineluctably, rather technical arguments against Darwinism amassed in the referenced literature, to which I instead will have to refer the interested reader for the full and detailed argument.[1600] The main lines of it can be summed up thus:

- The mechanisms of *random mutation* and *natural selection,* to which the most astounding feats of macroevolutionary transformation are imputed by the advocates of Darwinism, are in fact entirely unable to credibly account for the emergence of any single one of the countless *irreducibly complex* and cleverly engineered and intriguingly interrelated systems that are so typical of life, from the level of the molecular and genetic machinery of the cell up to the organs and senses of the organism, nor is there any sound and compelling empirical evidence in support of this core Darwinist hypothesis. For such a complex system as, for instance, an eye[1601], ear, or wing, even in a very primitive form, to take shape, a large number of *simultaneous, well-ordered,* and *mutually interdependent* changes is needed in the organism, and thus an equally large number of mutations must coincide in time so that the *per se* very complex changes in the genome will – via the likewise very complex decoding mechanisms in the cells – at exactly the right points in time during the ontogenesis create the enzymes that produce the proteins needed for the proper, once again extremely complex, sequence of developmental events to happen, thereby giving shape to the following three interrelated, but independent mechanisms, each of which also implies a high degree of complexity, viz. i) the organ constructed, ii) the wiring and other interaction mechanisms (such as nerves, muscles, blood vessels, etc.) needed to take advantage of and integrate the organ with the other parts of the organism, and iii) some mechanism (such as a centre in the brain) used to control the new organ via the aforementioned wiring. Not only do the wonders of this *prima facie* autopoietic synorganisation of life outdo the most well-disciplined and well-organised feats of human engineering by far, but through what Kapp used to call *Organprojektion,* it also serves as a, if not *the,* pre-eminent source of inspiration of these very feats of human engineering and technology.[1602] The idea that the complex engineering systems of living beings, showing all the signs of the most bafflingly *intelligent design,* can assemble themselves through random mutations and natural selection is simply as ridiculous as it is untenable.[1603] Although certainly no leading Darwinist (at least to my knowledge) has been an engineer or has had any extended experience of the construction of complex systems, the willingness of the intelligentsia and common people alike to be deceived by such Darwinist fairy tales remains a strange fact, which we will later attempt to make intelligible by some tentative hypotheses.

- The extraordinary life-enhancing and complexity-raising creativity of *random mutations* taken for granted in the Darwinian scheme is by no means substantiated by the extensive mutation experiments undertaken with, for example, bacteria and fruit flies *in vitro,* nor by any observations *in vivo.* On the contrary, such studies have shown mutations to be almost exclusively negative or neutral in their effects and to occur in recurrent patterns within very definite bounds that do not exceed the realm of *microevolutionary* change. Very few examples of genuinely life-enhancing mutations have in fact been observed (but for the emergence of resistance to antibiotics and poisons as a bye-effect of metabolic defects caused by muta-

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By the way, the peppered moth story cited by Johnson and recounted in innumerable textbooks of biology has recently been shown to be an artefact of odd research methods. See [Well99] and [Well00] p. 137 et seqq.

1600 See footnote 1596 on p. 330.

1601 Darwin himself famously confessed that the eye gave him a cold shudder. However, modern evolutionists believe that the eye has developed independently at least 40 (if not 65 or even more) times in a large number of different varieties (see [SM77]). The fantastic verbal prestidigitation by which [WG96] p. 234 et seqq. makes it seem "simple and natural" for an embryo to spontaneously generate an eye is typical of the sloppy, contorted discourse entertained in evolutionary circles. Cf. also [Wess93] p. 60 et seqq.

1602 See [Mite94] p. 20 et seqq.

1603 See [JS98] p. 80 et seqq. The attempts to shed light on living systems by the theories and concepts – or shall we say counterwords? – of systems, complexity, chaos, emergence, self-organisation, holism, and the like (see, for instance, [Wess93], [Good97], and [WG96]) seem, to the present author at least, vague and, on the whole, unpromising. On the concept of self-organisation, see [Over97]. For a criticism of the systems theory that preceded today's complexity furore, see [Berl76].

tions that, however, would decrease the vitality of the organism in a normal non-poisonous environment) and hardly any that clearly increase the complexity or informational content of an organism. On theoretical grounds, it seems extremely unlikely that a random mutation, which by virtue of its very randomness strikes blindly in the set of instructions encoded in a gene and, thus, almost certainly will corrupt this encoded message, should be able to effect a vitality-enhancing change in the genome. Roughly speaking, a mutation will be comparable to a random change to the binaries of a computer programme and about as likely to cause an improvement![1604]

- Likewise, judging from *empirical* evidence, the effects of *natural selection* (i.e. selection by "the survival of the fittest") and other varieties of selection suggested (such as Darwin's *sexual selection,* by which he, resorting to the most bald-faced anthropomorphism, tried to explain such patently fitness-reducing traits as the peacock's feathering or the stag's antlers[1605]) will rather be stabilising (weeding out the very unfit and very different), and, in general, hardly promoting change, as supposed in the Darwinian theories.[1606] Since the overwhelming majority of mutations are negative or neutral and *natural selection* will probably, at best, be able to eliminate only the very worst ones, the overall effect of the comparatively large number of slightly negative random mutations will arguably be a gradual decline of the quality of the gene pool of a population over time rather than a qualitative increase. The rapid changes that have been observed in small isolated populations (for example of the beak sizes and beak forms of birds on an isolated island) may, it seems, be better explained by chance genetic drift within the existing pool of alleles or by mating preferences than by natural selection and mutations and, in any case, stay within the very definite *microevolutionary* bounds of basically superficial, albeit at times visibly spectacular, parametrical changes of such properties as size, proportions, colour, and the like, essentially on a par with the range of modifications seen in breeding activities.[1607] Nothing clearly implying a growth in complexity and informational content, as predicted by the theory of *macroevolution,* has been recorded, nor any changes of the basic construction plan or indeed anything that could account for the development of new organs or functions or entirely new life forms. Likewise, traces of "nascent organs" (wings, eyes, trunks, ears, etc. in the making) have never been observed either in existing life forms or in fossils.[1608]

- Rather than the gradual transformational changes presumed by Darwinism, palaeontology presents a picture of extended periods of *stasis,* where little seems to happen, punctuated by short bursts of rapid change and often explosive creativity (such as the famous Cambrian explosion[1609]), where new forms of life abruptly and unexplainably appear and, partly at

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[1604] See [JS98] p. 63 et seqq. and [Wess93] p. 80 et seqq. Time and again, the idea of bridging the gaps of the fossil record by postulating the occurrence of occasional *macromutations,* each of which in one fell swoop is supposed to produce an entirely new life form, often referred to by Goldschmidt's term as a "hopeful monster" (see [Bowl88] p. 340), has been suggested (so e.g. in [Løvt87]). Besides lacking support in actual observations, this idea of "quantum evolution" seems to be ruled out by the extreme improbability of the chance concurrence of the numerous, each *per se* extremely unlikely, mutations needed for a *macromutation* to happen. Another problem for the hopeful monster would, of course, be to find a hopeful partner. Apparently, if the ideas of *common descent* and *transformationalism* are to be retained, the concept of *random* mutations as the mechanism of the evolutionary quantum leaps must be abandoned.

[1605] See [Macb71] p. 82 et seqq. Osborn's, Baldwin's and Lloyd Morgan's habit-based *organic selection* (see [Bowl88] p. 262 et seq. and [Hard68] p. 153 et seqq.) is yet another variant of selection, to which some Darwinians have had recourse in order to be able to foist in Darwinism a mechanism capable of the feats usually associated with Lamarckism and vitalist orthogenesis.

[1606] See [JS98] p. 70 et seqq. and [Dent85] p. 308 et seqq. Cf. also [Wess93].

[1607] See [JS98] p. 290 et seqq. [Macb71] p. 29 et seqq. stresses what all breeders and gardeners already know, viz. that attempts to cultivate certain traits (i.e. to demonstrate the alleged cumulative effects of selection) will bring about a decrease of general fitness of the organism (often even sterility) and frequently end up in a re-lapse into the original 'normal' form, which is to say that there are very definite bounds to what breeding, and thus also other kinds of selection, can achieve. Judging from such empirical evidence as there is, the contention that major macroevolutionary change can result from the accumulation of a large number or minor microevolutionary changes seems unjustified. Cf. also [Well00] p. 159 et seqq.

[1608] See [Dewa57] p. 165 et seqq.

[1609] Until the attempts to push the arrival of some of these life-forms back to a considerably earlier time by calculations based on so-called molecular clocks, the reliability of which are highly moot (see e.g. [JS98] p. 165 et seq. and [Well00] p. 45 et seqq.), are substantiated by actual fossil finds, little store should be set by them.

least, displace older ones. Additionally, the gaps between the different basic types of life are generally very clear-cut, each type having a distinct basic architecture, on which the different species and races may be regarded as mostly minor variations. In the fossil record, specimens that can be interpreted as transitional forms (missing links) between the main types of organisms are utterly rare; the evolutionary interpretation of the few instances suggested, such as the coelacanth, lung fish, *Icthyostega*[1610], *Archaeopteryx*[1611], or the species making up the so-called horse series[1612], is fraught with problems and, thus, extremely contentious.[1613]

- The increasing difficulties or total breakdown of various ideas and concepts that play or have played a key rôle in the argumentation for (neo-)Darwinism, such as:

  - Haeckel's so-called *biogenetic* law of *recapitulation*, i.e. the notion that the *ontogeny* (the epigenetic development of the individual) mirrors the *phylogeny* (the development of the species as a whole during history)[1614]

  - Haeckel's concepts of *vestigial organs* and *atavisms,* i.e. purportedly unnecessary or even detrimental rudiments of organs supposed 1) to reveal the descent of an organism from more primitive forebears and 2) to undermine the idea of perfection purportedly implicit in such notions as the Jewish-Christian idea of the divine creation of the life forms[1615]

  - the contradistinction between *homologous* and *analogous* organs, i.e. organs in different species having a similar function, which in the case of an *homology,* but not in that of an *analogy,* is explained through common descent[1616]

[1610] The results of the sequence analysis of mitochondrial DNA presented in [RJA98] (and [Rasm99a]) give the lie to the widespread 'scientific fact' that the vertebrate fishes are the ancestors of the amniotes and, thus, of all now living terrestrial animals, proving these groups to be two separate branches of the phylogenetic tree. Additionally, this study reverses the traditionally held order of the evolution of the fish, indicating that the lungfish and the coelacanth are to be regarded as more primitive than both cartilaginous fish, such as sharks, rays, or skates, and teleosts, the large group of fishes with a bony skeleton including such common species as herring, trout, cod, and the like. Generally speaking, the results of sequence analyses have been contradictory and puzzling and largely at odds with the traditional Darwinist "tree of life" (see [Well00] p. 49 et seqq.). Additionally, the surprisingly low estimate of the number of genes in man (30.000-35.000) that resulted from the human genome project has cast new doubts on genetic determinism, another seemingly irrefragable 'scientific fact', as such a low number of genes hardly will be able to account credibly for such a complex organism as man.

[1611] See [Well00] p. 111 et seqq.

[1612] See [JS98] p. 232 et seqq., [Well00] p. 195 et seqq., and [Dent85] p. 182 et seqq.

[1613] See [Dent85] p. 157 et seqq. and [JS98] p. 204 et seqq. The described picture has been well known since Darwin's time, although the difficulties of the Darwinist theories have since been considerably exacerbated through the steady growth of paleontological data. These gravamina have usually been met by two strategies by Darwinians, viz., firstly, a claim about the terrible imperfection of the fossil record and, secondly, a partial or complete abandonment of gradualism for a theory of rapid *cryptogenesis* in small, isolated populations (often presumed to have taken place after catastrophes or the like), lately revived by Gould and Eldredge under the banner of "punctuated equilibrium". As for the first line of defence, there is evidence that the fossil record may not be that bad: For instance, 85% of the genera of the now living vertebrates have been found also as fossils, and the record is even better for water living vertebrates, albeit worse for birds and other flying species (see [JS98] p. 209 et seq. and [Dewa57] p. 13 et seqq.). As for the idea of *cryptogenesis,* although it does indeed conform better to the extant data, it gives the impression of an untestable *ad hoc* hypothesis put together just in order to save the appearances of Darwinism. Additionally, although it seems that a small population will be more prone to change than a large one, chance-based *genetic drift* will in a small group tend to eclipse *natural selection* altogether and the possible range of the changes will by and large be restricted to the alleles already available in its gene pool, since the probability of beneficial random mutations will be even more minute in a small population than in a large one. Because of the interpretative difficulties, many palaeontologists now prefer to call life forms that display characteristics of multiple groups "mosaic forms" rather than "missing links", "transitional forms", or the like.

[1614] See [JS98] p. 176 et seqq.

[1615] See [Junk89], [BH93], and [JS98] p. 169 et seqq.

[1616] See [JS98] p. 152 et seqq., [Well00] p. 59 et seqq., and [Dent85] p. 142 et seqq. Cf. also [Hard67] p. 160 et seqq. and [Hard68] p. 210 et seqq. for a discussion of some purportedly *homologous* organs, which on closer inspection turn out to differ both epigenetically and genetically, emerging from different parts of the embryo and being controlled by different genes. The extensive reuse of similar structural solutions in species not closely related to each other, such as the strange and striking parallelisms of various unrelated species of marsupial and placental mammals (such as the marsupial and placental versions of moles, wolves, and jerboas; see [Hard68] p. 199 et seqq.) seems to suggest some kind of archetypal basis of life or, perhaps, such concepts as Rupert Sheldrake's "morphic resonance" (see [Shel81] p. 95 et seqq. and [Shel95]), Alister Hardy's "blue prints" (see [Hard67] p. 163), Driesch's "entelechy," or von Uexküll's "Bauplan". In any case, the traditional Darwinist explanation to such phenomena by "convergent evolution" seems strained in the extreme (particularly in the

- *blood precipitation* tests as a measure of how closely two species are related[1617]
- some kind of *abiogenesis,* i.e. a purely naturalistic explanation of the origin of life as a result of physical and chemical processes[1618]

Repeatedly, one finds amongst modern Darwinists a strange mix of rhetorical vehemence and naïveté, where the spate of often extremely aggressive rhetoric or even sheer abuse[1619] relied on to paper over the enormity and the overwhelming difficulties of their claims, albeit but "spiritual despotism"[1620] clad in the gaudy garb of rhetoric trickery well-known since the heyday of the Greek sophists[1621], flabbergastingly has

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light of the quite different environmental settings of the parallel marsupial and placental species) and also in fundamental conflict with the paramount rôle generally accorded to chance in Darwinism.

1617 See [Dewa57] p. 179 et seqq. Cf. also [Smit84b] p. 77 et seqq.

1618 See [TBO92], [JS98] p. 135 et seqq., [Well00] p. 9 et seqq., and [Dent85] p. 249 et seqq. Cf. also [Shap87]. Nor is the purported *abiogenesis* (usually believed to have happened only once so as to ensure the *common descent* of bacteria, plants, animals, and even viruses) the only transformation difficult to conceive of plausibly in a Darwinist frame of reference; others will include the transformation of i) pre-cellular 'life' into the cell ii) *Protozoa* (one-celled organisms) into *Metazoa* (multi-celled organisms), iii) asexual life forms into sexual ones, iv) invertebrates into vertebrates, v) fish into amphibia, vi) amphibia into reptiles, vii) reptiles into birds and mammals, viii) the ordinary genetic code into one of its of variants (such as that of the *Paramecia),* ix) separate runs of genetic code into *overlapping genes,* x) one number of chromosomes into another quantity, xi) non-parasites into parasites, or xii) non-conscious life forms (if such exist) into conscious life. See [Rand77] p. 214 and [JS98] p. 296 et seqq.

1619 A few examples of such Darwinist vituperation and verbal duress will suffice to illustrate the extremely rancorous and contumelious tone of neo-Darwinist discourse: Prof. Dawkins' baffling dictum: "It is absolutely safe to say that, if you meet somebody who claims not to believe in evolution, that person is ignorant, stupid, or insane (or wicked, but I'd rather not consider that)" (quoted in [John93] p. 9 from a *New York Times* book review), Gould's no less baffling barb "anyone who does not honor Darwin inevitably attracts the speculative psychiatric eye to him" (quoted in [Jaki90] p. 146), Dawkins' characterisation of the science journalist Richard Milton's fascinating *Shattering the Myths of Darwinism* as "loony", "stupid", "drivel" and its author as a "harmless fruitcake" who "needs psychiatric help" (quoted in [Milt97] p. ix from *New Statesman* 8.28 1992), *Nature's* consignment of Sheldrake's well-argued, neo-organismic *A New Science of Life* to the flames ("the best candidate for burning there has been in many years" as cited in [Shel81] p. 221), and Richard Leakey's reprobation of Cremo's and Thompson's meticulous survey of the fossil evidence for the early presence of human beings: "Your book is pure humbug and does not deserve to be taken seriously by anyone but a fool" (cited from the back flap of [CT99]; more of the same kind can be found in [Crem01]). On the unconscionable hardships – ranging from derogatory comments, censorship, and death threats (!) to refusal of degrees and of admittance to graduate programmes, denial of tenure or promotions, and ungrounded firings and terminations – that regularly befall American students and scientists, who harbour, or are suspected of harbouring, sympathies for creationism, see [Berg84] and [Berg96].

1620 [Luba71] p. 141 et seqq.

1621 The tautological character of the fundamental Darwinian thesis of the "survival of the fittest" (fittest, to wit, for survival!) has often been noticed, e.g. by Popper (see [Popp76] p. 167 et seqq.; cf. also [Macb71] p. 62 et seqq.). The inanity of this and kindred evolutionist statements can easily be seen by their applicability to all kinds of phenomena: The keen pan-Darwinist will see the survival of the fittest nations, tribes, and races in history, the survival of the fittest ideas (memes!) in intellectual debates, the fittest car models on the car market, the fittest scholars in academic life, and so on (cf. [Clar58] p. 98 et seqq.; [Smol97] provides a recent example of such extreme pan-evolutionism, the archetype of which will be Herbert Spencer's philosophical system). Clearly, everywhere the fittest will survive and the poor unfits be doomed in the atrocious omnipresent struggle for existence! Unfortunately, such vapid generalisations will be of little avail, if we want to *understand* the intricate nature of nations, intellectual life, cars, or dons and how they have reached their current level of sophistication. Since little can be known of history before the arrival of written documentation and the complexity of life is a brute fact that cries out loud for explanation, the ineptitude and impotency of Darwinism and kindred schemes will not be as conspicuous in biology as when applied to the history of mankind, religion, social life, etc., where the evolutionist fad has, thankfully, long since resided (although the dead duck seems to have come to life again recently as socio-biology).

Structurally, Darwinism belongs to the secular progressivist historiosophies – some other well-known examples will be Vico's three ages of the gods, the heroes, and men, the Kant-Laplace nebular cosmogony (prefigured by Lurianic Kabbalah with its concept of divine *tsimtsum,* contraction), Voltaire's, Turgot's, and Condorcet's notion of *les progrès de l'esprit humain,* Lessing's proclamation of the Age of Reason as the third stage after the Ages of the Law and the Gospel, Herder's philosophy of history, Hegel's dialectics, the Marxian scheme of historical progress through class struggle, Comte's three-staged theory of history, and Spencer's general theory of evolution – that mushroomed during and after the Enlightenment and can be interpreted as an "immanentisation" or "secularisation" of the Jewish-Christian ideas on eschatology, *accommodatio* (viz. of God's revelation to the human capability of understanding it), and God's providential care for mankind in history. In particular, such staged theories of progress have come to be associated with and derived from Joachim of Fiore and his teachings on the three kingdoms of the Father (the pre-Christian, Jewish era), the Son (the Christian era), and the Spirit (the coming era of universal happiness when God will become all in all through the workings of the Holy Ghost; see [Reev77], [Reev69], [Benz69a], [Cohn70a], [McGi85], [McGi94b], and [Voeg87] p. 110 et seqq.). Important signposts along the road to the secularised modern epochal consciousness, were Petrarch's distinction of the classical, dark, and modern ages and Vasari's usage of the term *la renascita* to signify the modern epoch he lived in, ever since known as the *Renaissance* (see [McKn89] p. 9 et seqq.). On the "nebular hypothesis" and evolutionism, see [Brus87].

been able to persuade not only its originators and their devout following, but, indeed, the lion's share of the modern world – inside and outside an Academe, whose vaunted critical attitude seldom seems to be brought to bear unless backed up by fashion and a sizeable community – to sheepishly bow down in the house of the Darwinian Rimmon. But stubborn dogmatism and vehement and high-pitched rhetoric usually betoken deeper motifs, revealing a moment of disingenuousness and closure in the mind of the one who, rather than searching for truth without fear or favour, struggles hard and apparently not without a certain pang of desperation to convince both himself and others of the conformance of the world with his own predilections.[1622] Although anti-Darwinists are regularly accused of wishful thinking rooted in religious belief, and in some cases perhaps rightly so, wishful thinking and a, if not religious, at least quasi-religious commitment to certain beliefs will be at least as operative amongst Darwinists, whose rhetoric more often than not seems to be imbued by a strong nihilist pathos and anti-religious and anti-clerical, not to say anti-theistic or anti-Christian sentiments. For those who want to penetrate to the truth of the matter of the origin of living beings, wishful thinking, rhetorical trickery, and propaganda, be it Darwinist or anti-Darwinist, will, however, be of no avail.

Darwin's ideas are part of the much larger complex of nihilist, cynical, and pessimist thought that came to flourish in the middle and later part of the 19th century, materialising out of a plethora of devious currents and eddies of the *Zeitgeist*, including 1) Romantic emotionalism (as in its thrills of *Weltschmerz, Waldeinsamkeit,* and similar sentiments), gnosticism, neo-paganism, and preoccupation with the night-side of existence, 2) the secularisation of, or perhaps rather perversion of, a certain –also *per se* fairly unsavoury – variety of self-righteous moralism – usually associated with some forms of Calvinism and Puritanism –, according to which worldly success is to be regarded as a token of heavenly approval, into the paradoxical espousal of greedy self-interest, egotism, and might-is-right attitudes, and 3) a peculiar form of hard-boiled reflection on nature, society, and politics, and, in particular, on the harsh social conditions that prevailed in the time period that extends from the religious wars, which followed upon the Reformation, to the end of the industrial revolution (as epitomised in such catch phrases as Hobbes' "bellum omnium contra omnes", Mandeville's "private vices, publick benefits", Erasmus Darwin's "eat or be eaten", Malthus' "struggle for existence", or Spencer's "survival of the

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In parallel with the rise of progressivism during the 18th and 19th centuries, an antithetical undertow of pessimism and a general sense of cultural decline also grew rapidly in force and today seem to have got the upper hand. The serious questioning of progressivism was broached by the reaction to the lunacies of the French revolution and gained impetus by the influence of Nietzsche, who, wielding his nihilistic sledgehammer against all and anything, here for once actually hit the mark. During the last century, the modern progressivist "immanentization of the Christian eschaton" (Eric Voegelin in [Voeg87] p. 121) or secular "Heilsgeschichte" (Karl Löwith in [Löwi53]), making man's salvation dependent on his own actions rather than on God's and trivialising it into the utopian reconstruction of this world *(the saeculum)* through politics, science, medicine, and technology, has been increasingly discredited by all its doubtful ramifications as well as by the unedifying course of modern history, thereby also undermining the legitimacy of what is often referred to as the "modern" or "Enlightenment" project and fomenting the deep sense of crisis, which has prevailed more or less permanently all since the First World War. See [McKn91] p. 6 et seqq. for an interesting discussion of the famous Löwith-Blumenberg debate on this issue. For a survey and critical appraisal of modern cultural pessimism and ideas of decline, see [Herm97]; cf. also [Bran98]. On the history of the idea of progress, see [Tegg49], [Bury60], [Daws], [Tuve64], [Manu65], [SG75], [Poll71], [Nisb80], [Frän80], [Ross84], [Bowl89b], [MWZ95], [Benz83a] p. 27 et seqq., [Funk86] p. 202 et seqq., [Ovit87] p. 19 et seqq., [Coud99] (in particular, p. 320 et seqq. and p. 334 et seqq.), [Edel67], and [Dodd73b]. Cf. also [Benz77], [Cost93], and [Elia71]. On the related ideas of the perfectibility of man and the *Übermensch,* the flatulent descendant of the Renaissance magus and the Romantic genius, see [Pass72] and [Benz61]. On the history of prophetic interpretation and apocalyptic thought within Christianity, see [Froo46], the *magnum opus* of the leading Adventist theologian of the 20th century. Cf. also [Reev99], [Boye92], [Thom96], and [Webe99].

1622 Cf. C. S. Lewis' statement in a letter to the anti-evolutionist Actworth (see [Numb93] p. 153): "What inclines me now to think that you may be right in regarding it [evolution] as *the* central and radical lie in the whole web of falsehood that now governs our lives is not so much your arguments against it as the fanatical and twisted attitudes of its defenders." Furthermore, R. F. Baum, commenting on the lasting impact of Darwin, Freud, and Marx, "the Doctors of modernity", whose current influence he parallels to that of the great Schoolmen in the Middle Ages, aptly points out (see [Baum88] p. 120): "Basically at issue, functioning as a fundamental principle and accounting for the persistent adulation of writers whose crucial errors and inadequacies are increasingly admitted, is philosophical naturalism and what that comes down to, atheism. Though almost no ones says this, will not reflective people quickly perceive its truth? Is it not in academia at least an open secret?" Cf. also [Luba71] p. 7 et passim for a discussion of the *antitheism* of modern atheist humanism. Notably, many leading proponents of Darwinism and kindred varieties of hard-boiled scientism, such as Richard Dawkins, John Maynard Smith, and John Maddox (the former editor of *Nature*), are affiliated to the *Humanist Association,* a quasi-religious organisation somewhat in the spirit of Comte's church of positivism (see http://www.humanism.org.uk/who_bha.asp; cf. also [Kurt73] and http://www.americanhumanist.org/about/humanists-year.html, a list of the recipients of "the humanist of the year" award conferred by the American branch of this organisation), whereas many others, like J. B. S. Haldane, Stephen Jay Gould, or Richard Lewontin, are devotees of another of modernity's great quasi-religions, to wit Marxism. The rather obvious quasi-religious character of the various, often fervently held beliefs in ideologies such as Darwinism, humanism, socialism, positivism, nihilism, and kindred isms have repeatedly been pointed out and analysed, for example by Gustave Le Bon (see [LeBo79]), Eric Voegelin (see [Voeg39] and [Voeg97] p. 55 et seqq.), and Gary North (see [Nort89]). Cf. also footnote 1590 on p. 328 above.

fittest").[1623] These thought structures, albeit having their immediate precedents in the Enlightenment, can be traced much further back through the centuries[1624] and will have their ultimate roots in the Sophistic Enlightenment of fifth century Greece.[1625] Behind the dismal ways of thought of the 19th century 'maîtres du soupçon', the masters of suspicion, to adopt Ricœur's famous and felicitous characterisation[1626], there was a kind of juvenile *metaphysical pathos*[1627] of iconoclasm, discontent, and rebellion, a pathos that glorifies and revels in the exposure of purported illusions, turning things topsy-turvy, and thinking and doing the forbidden, offensive, or disgusting.[1628] But by no means will such an immature and rebellious mindset be apt to guide man towards the truth about being and life. If, as argued above, a sincere and earnest analysis of the facts must needs reveal Darwinism as a delusion animated by a pathologic, self-deceiving urge to explain away and dominate the mystery of being through a kind of mental violence rather than to approach and find out about it with an open and humble mind, we must ask what the origin and raison d'être of this grand pathology may be and how it has been able to gain such a tyrannical sway over the minds of men. In short, we must now contemplate the great mystery of why modern man is so peculiarly game to blench the obvious facts of life and rise to the bait of a rancid nihilist carcass, when he could instead have regaled himself on the manna of Heaven.

1623 Somewhat oddly, the ideas on the beneficence of self-interest (rather than faith) in holding society together seem to have their roots in the writings of the pious Jansenist Pierre Nicole, from whom Pierre Bayle later extracted them and ventured to popularise them. Cf. [Woot92] p. 51. For a general study of the detrimental effects on society and human mores of this celebration of greedy self-interest through the "language of science", which, in particular as entertained by the disciplines of modern economics, biology/sociobiology, and behaviouristic psychology, the legacy of the ruthless cynicism bequeathed to us by Adam Smith, Charles Darwin, and B. F. Skinner, gradually has corroded the "language of morality" and the civic virtues undergirded by traditional religion and moral philosophy, see [Schw86].

1624 On the history of the complexly interrelated strains of thought (such as Averroism, Alexandrism, nominalism, scepticism, deism, freethinking, libertinism, Machiavellian political cynicism, political radicalism, anti-clericalism, Biblical criticism, various philosophical and theological aberrations, etc.) that paved the way for the nihilism of the 19th century (and, alas, of our own times), see [Buck87], [Kors90], [Hunt90], [Turn86], [Gay98], [HW92], [Beck32], [Baum70], [Popk79], [Haza54], [Haza73], [Gay67], [Gay70], [Febv42], [Kris68], [Mell78], [Walk72], [Plut86], [Spin60], [Wade71], and [Chad90].

1625 In ancient Athens, the sinister consequences of these 'Enlightenment' ideas on the ways and mores of men were unsurpassably diagnosed by Thucydides in his account of the follies and atrocities of the Peloponnesian war, such as the unspeakable horrors of the civil war on Corcyra and the annihilation of the population of the small island of Melus by the Athenians following upon the Athenian delivery of an exemplary proto-Darwinian sermon in the famous Melian dialogue. The erosive impact of the Sophistic agenda was finally staunched by the philosophical and religious-ethical counter-offensive of Socrates, Plato, Aristotle, the Stoics, and others.

1626 These will include the *Junghegelianer* (Feuerbach, Bauer, Stirner, Marx, and others), the German materialists (Büchner, Vogt, Moleschott, etc.), the French *idéologues* (such as Cabanis), Comte and his positivist following, Haeckel and his Monist league, the English Benthamists and naturalists (Mill, Spencer, T. H. Huxley, George Eliot, and many others), liberal and relativist theologians (such as Schleiermacher, Strauß, Renan, and F. C. Baur and his Tübingen school), and numerous others not so easily classified, such as Nietzsche or Freud, just to name some of the most influential and best known personages, who provided the foil and paved the way for Darwin and his theories as well as their tremendous éclat.

1627 Cf. [Love64] p. 10 et seqq.

1628 See [Löwi95], [Barz58], [Luba71], [Camu87], [Baum88], [Chad90], [DeMa00], [Weis79] vol. 1 p. 378 et seqq., [Haye64] p. 191 et seqq., [Voeg97], and [McKn89] p. 91 et seqq. Cf. also [Lato93] p. 43 et seqq. As for Darwin's intellectual and religious development and his dealings with 19th century free-thinkers and radicals, see [DM91] and [Brow86] (cf. also [Desm89], who casts light on the rôle played by pre-Darwinian evolutionism in political radicalism, [Desm97] on Thomas Huxley's use of Darwinism to prop up his own radical, anticlerical agenda, and [Moor94]).

3.3 PLUMBING THE DEPTHS OF MODERNITY

> *No one is obliged to take part in the spiritual crisis of a society; on the contrary, everyone is obliged to avoid this folly and live his life in order.*
>
> *Eric Voegelin*[1629]

If, as we argued above, metaphysical naturalism is conspicuously wrong-headed and incapable of dealing plausibly even with the most fundamental and obtrusive facts of human existence, such as consciousness, the exquisite order of being that everywhere meets the eye, man's deep-seated religious inclinations and moral intuitions that arguably constitute the very essence of his humanity, or the full range of human experiences from the ordinary to the very extraordinary, if on closer inspection its Darwinian cosmogonic myth, albeit disguised in the meretricious trappings of scientific discourse, turns out to be a house of cards built on sand, if the obvious detrimental effects of naturalism on the morality and conduct of men and nations make it an ideology more fitting for waylayers and mobsters than for those, who lay claim to the noble pursuits of science and philosophy, which words, as everyone knows, but few take seriously, actually mean *knowledge* and *love of wisdom,* and if, furthermore, the explanatory inferiority and moral balefulness of naturalism have been widely perceived and acknowledged all over the world in all ages, then its popularity during the last few hundred years in our own culture – and in particular amongst educated people and men of science – indeed seems peculiar, nay an oddity that clamours for explanation. How could it be that Western science, which was launched by apparently pious Christian men as an endeavour to discover the footsteps of the Creator in His works, has metamorphosed into such a formidable foe of all piety and religion (and, in particular, of the Christian religion, from whose cradle it sprang) and Academe, the purpose of which was originally the education of the Christian clergy, has become such a redoubt of atheism, naturalism, and all kinds of pseudo-scientific nihilistic speculative philosophies, such as Darwinism, Freudianism, Marxism, positivism, existentialism, feminism, 'skepticism', postmodernism, and innumerable other isms and ideologies, notwithstanding that the hard core of factual results amassed in the scientific pursuit hardly can be said to undermine or detract from, but rather to considerably substantiate and strengthen the pious awe and wonder the founders of science felt upon the contemplation of God's wisdom as revealed in the splendours of His creation? Although pat answers will be of little use when considering this extraordinarily tangled skein of problems, I should here like to commence the lengthy exploration, on which I will now embark, by pointing to the thought of the late Eric Voegelin, the incisive philosopher and scathing critic of modernity, whose star has been in a steady ascent during most of the latter part of the 20th century.[1630]

1629 [Voeg97] p. 15.

1630 [Pric94] (non vidi [Pric00], its successor) provides a comprehensive bibliography of Voegeliniana, of which several updates have appeared in the *Voegelin—Research News* (see http://vax2.concordia.ca/~vorenews). An excellent dictionary of Voegelin's rather idiosyncratic terminology is available at http://www.salamander.com/~wmcclain/ev-dictionary.html. The home page of the Eric Voegelin Institute of Louisiana State University at http://www.ericvoegelin.org also holds interesting materials. As Voegelin, like Plato and Schelling, both of whom he much admired, diligently revised and altered his views as long as he lived and, indeed, was a sworn foe of all dogmatic philosophical system-building, any attempt to represent his outlook, such as the one given below, primarily based on [Voeg97], [Voeg87], [Voeg96], and to a less extent on his magnum opus [Voeg56], will, at best, be able to provide some snapshots of it. Of the quickly growing secondary literature on Voegelin's thought, I have found [Webb81], [Sand91], [McAl96], [Coop99], and [Hugh99] useful. On Voegelin's intellectual background and debt to Othmar Spann's and Max Scheler's ideas, see the interesting studies [Petr98] and [Petr00]. An important source of inspiration for Voegelin's gnostic hypothesis was the Catholic theologian Hans Urs von Balthasar's study of German apocalypticism, [Urs47] (see [Voeg96] p. 65 et seq.).

Corruptio optimi pessima.

Anonymous

The more fervently all human energies are thrown into the great enterprise of salvation through world-immanent action, the farther the human beings who engage in this enterprise move away from the life of the spirit. And since the life of the spirit is the source of order in man and society, the very success of a Gnostic civilization is the cause of its decline.

Eric Voegelin[1631]

It was Voegelin's intriguing and much-debated thesis, that there is a deep-seated disorder in our civilisation rooted in a 'gnostic' sentiment of alienation *(allotriosis)* and extreme discontent with a reality perceived as utterly evil, in the consequential 'gnostic' turn away *(apostrophe)* from the divine ground of this reality, and in the crowning and pre-eminently 'gnostic' claim to self-salvation and liberation from the prison of reality through absolute knowledge *(gnosis),*[1632] coming clearly into sight for the first time in the gnostic-apocalyptic heresies, which emerged as a distortion and gloomy shadow of the Christian faith in the early years of the Christian era, and which from that time have reasserted themselves ever and anon during the course of history.[1633] According to Voegelin, the semblance of certainty about the meaning of history and the adept's place in it as well as the promise of extraordinary experiences offered by the gnostic systems tend to present a very potent allure as an escape from meaninglessness and despondency to those lapsed from, unsatisfied by, or, for some reason or other, opposed to Christian faith, which as just *faith* in a transcendent, invisible reality and the *visio beatifica* in the next world will prove too difficult for many who lack "the spiritual stamina for the heroic adventure of the soul that is Christianity".[1634]

We may compare Voegelin's observation to the analysis made by Craig M. Gay in an influential article, where he, taking advantage of Kierkegaard's conception of "sygdommen til døden", points out how the Christian gospel, by the stark existential choice it presents to each man of either submission to God in faith or

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[1631] [Voeg87] p. 131

[1632] Arguably, 'gnosticism' in the sense given above will not be altogether unique to the Western world. For one thing, it seems possible to find many gnostic traits in Buddhism or Jainism. One may be inclined to conjecture that gnostic attitudes would generally be a response to periods of extreme hardships and disasters, terrible wars, plagues, famines, etc., but this seems far from always being the case. On the contrary, Western gnosticism first appeared during the prosperous era of the *pax Romana* and, rather than on the dispossessed and ill-fated gnostic-pessimistic ideas seem to have exerted their main attraction on the wealthy, on jaded intellectuals, and on mollycoddled princes and aristocrats – from Buddha and Marcion to Leopardi, Schopenhauer, Harold Bloom, and Elaine Pagels. Apparently, gnosticism will more often be the symptom of the ennui and squeamishness of a pampered, (hyper-)sensitive and (hyper-)critical soul than the backwash of bad fortunes.

[1633] It is a common, if natural, mistake amongst Voegelin's critics to understand the term 'gnosticism' too literally, to have it refer to the ancient sects of Gnosticism, their teachings, and spiritual successors, thereby making Voegelin primarily a tracker and critic of the influences of this movement and its offshoots. In Voegelin's usage, 'gnosticism' will, however, primarily denote a distinct existential attitude, a pattern or structure in consciousness, as it were (cf. [Voeg78]), that happens to be very explicit in some forms of ancient Gnosticism, although by no means exclusive to these. According to [Webb97a], Voegelin in his old age expressed dissatisfaction with his own choice of this imprecise term and suggested "pneumapathological consciousness" or "disorientation" as alternative designations, and he also mentioned other traditions, such as 'metastatic' apocalypticism, Neoplatonism, hermeticism, magic, etc. as of an import similar to that of 'gnosticism' (see [Beam98], [Voeg96] p. 66 et seq., and [Voeg78]). Cf. also [McKn89] p. x, where is stressed the difference between the optimistic thisworldliness of modern 'gnostic' tendencies – as seen in the Hermetic-Cabalistic "ancient wisdom" tradition known as *prisca theologia* and its various latter-day political, philosophical, and scientistic offshoots, all aiming at a major utopian reform of this world, politically, religiously, and scientifically – and the otherworldliness of the pungently dualistic and pessimistic ancient brand of Gnosticism, to which this world was but an execrable prison to be escaped from by ascetic austerities or *anomie*. Somewhat ironically, in our own age the more optimistic, reformatory form of 'modern gnosticism' seems once again to have been overshadowed by sentiments akin to those of the original brand of pessimistic Gnosticism. On ancient Gnosticism, see [Rudo94] and [Jona91] and p. 359 below. Cf. also [Knox61], [Lind84], [Dani68] p. 330 et seqq., and [Cohn70a] p. 150, p. 184 et passim.

[1634] [Voeg87] p. 121 et seqq. Cf. also [Voeg87] p. 74 et seqq. Much has been written on Voegelin's ambiguous, not to say dubious, theological views; see, for example, [Niem95], [Jard95], [Cari91], [Rhod83], [Fede94], [Hugh99] (includes a good bibliography), and the papers presented at the panel on Voegelin and the Reformation at the *Eric Voegelin Society 16th Annual Meeting* in 2000, available at the web page http://www.artsci.lsu.edu/voegelin/EVS/PANEL5.html.

rejection of God's grace, inevitably implies a keen intensification of man's self-consciousness, will, and selfhood that will create an unbridgeable gulf between the gospel hearer and pre-Christian man.[1635] For those who, having gone through the ordeal of this pivotal choice, reject Christ as well as those who try to escape the choice altogether, there is no question of returning to an innocent pre-Christian condition and avoiding the new "earnestness of existence", but the only option that remains is the pathologic "Promethean despair" of autonomous self-realisation, the sickness unto death, "sygdommen til døden", which also seems to be at the root of ancient Gnosticism. The modern habit of losing oneself in utopian projects of social change and economic and technoscientific progress, as well as their postmodern, ironic antithesis are, according to Gay, all expressions of such Promethean despair. But can really a plausible link be established between ancient Gnosticism with its intense otherworldliness and the modern project with its intense thisworldliness?

Having gone through a process of what Voegelin calls 'immanentization', by which the original hopes for a transcendental escape from this world, were, as it were, brought down to earth and turned into utopian projects,[1636] the gnostic-apocalyptic thought structures gave birth to the virulent impulse of a flight not from, but to this world, or rather to a reconstructed, transfigured, utopian version of it – in short the "revolt against reality" so typical of modern Western culture. The desired dominion of man over being necessary to accomplish the reconstruction of the unsatisfactory world, human society, and man himself was secured by nothing less than "the murder of God", who, convicted of demiurgic responsibility for the present purportedly imperfect, unjust, and evil world, was declared to be a useless invention or projection.[1637] Thus, abolished through a most astounding act of Faustian bargain[1638], God was, seemingly at least, forced to hand the reins over to man, who as the next step in his 'egophanic revolt' now pretends to be God himself, having replaced the Christian *amor Dei* together with the salvation through divine grace and the expectation of a divine *parousia,* with the gnostic-humanist *amor sui,* self-salvation through intramundane activities, and hope for a profane *parousiasm*[1639] – although all this is of course nothing but sleight-of-hand, hubris, and blasphemous lunacy.

In Voegelin's interpretation, all the modern ideological *systems* ('isms'[1640]), including the multitude of philosophical systems and political ideologies and also phenomena such as scientism, positivism, progressiv-

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1635 [Gay93]

1636 The concept of *immanentization* will be discussed at somewhat greater length below on p. 442 et seqq. A long time before Voegelin's acme, Chesterton aptly described the omnipresence of distorted Christian ideas thus (see [Ches1908] p. 39): "The modern world is full of the old Christian virtues gone mad." For one thing, the many strange expressions of the vague sense of guilt and need for penance amongst modern secular men, and in particular with intellectuals, come to mind. Cf. also [Fier53], [Spin60] p. 243 et seqq., [Maur83], and [Wals90] p. 123 et seqq.

1637 See [Voeg97] p. 35 et seqq.

1638 Cf. [Spen97] and [Barz64] p. 20.

1639 Having dealt with Heidegger's ideas about the advent of (immanent) being, [Voeg97] p. 34 defines *parousiasm* as "the mentality that expects deliverance from the evils of the time through the advent, the coming in all its fullness, of being construed as immanent". He contrasts the contemporary phase *parousiastic* of Western gnosticism with the earlier *chiliastic* one. Cf. also [Voeg87] p. 184 et seqq. for a discussion of the abolition of *amor Dei.* Tage Lindbom in [Lind79] p. 42 et seqq. provides a somewhat similar analysis of the roots of the *ressentiment* that, according to Lindbom, is the mainspring of modernity: (id. op. p. 45) "Ingenting kan vara mer raffinerat i sina uppenbarelseformer, ingenting kan vara mer artikulerat. Än uppenbarar sig ressentimentet i vetenskapens sanningssökande dräkt, än i lågkyrkliga attacker mot sakrala värden, än i de politiska tumulten, än i konstens tempel, än under den sociala idealismens banor (sic!)." He points to the European heresies, pseudo-Christian and secularised Christian conceptions as the root of this ressentiment, and concludes, "Steg för steg utrustas Människan med gudomliga egenskaper, intar Guds plats." (id. op. p. 46) "Den gamla Gudsgemenskapen, grundad på en strävan att lyda Gud är borta, och så blir konsekvensen, att Människorikets invånare söker likna varandra. Jämlikheten, identifikationen blir den sekulariserade människans »gudsgemenskap». Att förneka denna jämlikhet, att vägra underkasta sig identifikationsprocessen, att ställa sig utanför den egalitära »gudsgemenskapen» det blir då Människorikets form för »ateism».. Ve den som ställer sig utanför denna gemenskap, ve den som söker förhindra, att de sista resterna av olikheter utplånas. Den osynliga ostracismen, med vilken de egalitära samhällena arbetar, den obönhörliga och oavbrutet växande konformismen, varom Tocqueville redan för ett och ett tredjedels århundrade sedan gav skakande vittnesbörd, får nu sin naturliga förklaring. Ty då den trygghet, som metafysisk gemenskap skänker, är borta, återstår det att söka trygghet och tröst i en självförgudande mänsklig gemenskap, grundad på högsta mått av likhet. Är trösten klen, så är kampen för den totala egaliseringen, mot olikheternas sista rester så mycket betydelsefullare och så mycket mer emotionellt berikande. … Här har ressentimentet en källa av outsinlig kraft: den mänskliga vanmaktens kollektiva förskansning bakom murar av rättfärdighetslidelse. Den egalitära kampen är ressentimentets bitterljuva hämnd mot det förnäma och upphöjda, den är en kamp för vanmaktens fördöljande och förnekande, ett medel till trygghet och tröst." (id. op. p. 47 et seq.)

1640 Cf. [Voeg78].

ism, psychoanalysis, etc., are essentially *ersatz religions,* giving expression to a gnostic 'pneumopathologic'[1641] mind-set, which shows, inter alia

1) in the rash willingness to substitute constructed 'second realities' or 'dream worlds' for actual reality and replace *philosophia,* the love of and open quest for wisdom and knowledge, with *philodoxy,* the love of (delusory) subjective opinions (made to seem plausible by the magic charms of rhetoric and sophistry[1642]) and the dogmatic espousal of the aforementioned types of closed *systems* of alleged 'actual knowledge' (i.e. *gnosis)*
2) in the prohibition of questions and the inhibition of discussion except on terms of the *system* embraced and its pseudo-reality[1643]
3) in the diverse ramifications of the *libido dominandi* that constitutes the ulterior motive of all the gnostic constructions, viz. an inordinate obsession with power, control, and instrumental reason – Max Weber's *Zweckrationalität –,* based on an unshakeable belief in one's own possession of absolute, saving knowledge and in the legitimacy of one's claims, underpinned by the illusory choreographic manipulations of the constructed 'second reality'[1644]
4) in the development with leading gnostic ideologists (Voegelin mentions Hegel, Marx, Comte, Nietzsche, and Heidegger in this context) from "deception", which initially may have been unintended, over "intellectual swindle", as the error is detected, but persisted in against better judgement, to what amounts to a lustful "demonic mendacity" rooted in the will to power and the revolt against God and maintained by the prohibition of questions.[1645]

The gnostic dance macabre eventuates in all the well-known horrors of 20th century history – the corollary of the murder of God proving to be the murder of men[1646] – as well as the present 'derailment' of Western thought and civilisation.[1647] Since the order of being and the nature of man are given and not amenable to man's control through magic incantations, the gnostic projects, it appears, infallibly end up in, at best, disappointment, or, at worst, apocalyptic disaster. As it turns out, man cannot be transfigured into God or gnostic superman, nor can paradise be created on earth; such aspirations will only render man a demon or lunatic and his utopia hell.

1641 This term, borrowed from Schelling, Voegelin used to designate the pathological tendency of gnostic thinkers arbitrarily to omit some crucial element of reality when creating the gnostic fantasy reality. See [Voeg97] p. 70.

1642 On the relationship between magic and rhetoric, see [Romi75]. Cf. also [Voeg77].

1643 Cf. the discussion of *Normalisierung* in [Noël28] vol. 2 p. 779 et seqq. Some striking examples of this phenomenon are Marx' and various other dogmatic atheists' prohibition of religious questions about the meaning of life and the origin of the cosmos and man, the positivists' prohibition of all metaphysical questions, the Darwinists' prohibition of teleological causes in biology, or Hume's and latter-day skeptics' interdict on miracles. Arguably, all these strange bans of certain kinds of discourses can in the end be traced back to Ockham and his nominalistic razor (see below p. 344).

1644 For a discussion of the concepts *libido dominandi, libido sentiendi,* and *libido sciendi,* see [Aesc98] p. 74 et seqq.

1645 See [Voeg97] p. 23. Cf. also [Baum88] p. 115 et seqq. The concepts "intellectual swindle" and "demonic mendacity" may *prima facie* seem harsh and preposterous, but are, I believe, founded in a realistic psychology of intellectual man. The Scotist view of sin as grounded in a perverted will rather than in intellectual error and Schopenhauer's notion of reason as subordinate to will clearly have bearings on Voegelin's approach. Although too one-sided in their explanatory models, [Jone93], [Jone94], and [Jone95a] (cf. also [Bill80] p. 52 et seq.) cast valuable light on the way ideological thought, albeit couched as a quest for the truth, may actually be decisively shaped by ulterior motifs. Cf. also the perspicacious discussion of the *trickster* figure in [Hans01b] and of Hegelian philosophy in [Bill80] p. 226 et seqq.

1646 "The deicide of the gnostic theoreticians is followed by the homicide of the revolutionary practitioners" ([Voeg97] p. 43). Remarkably, also the "humanistic" quasi-religion embraced by many leading scientists of a positivist or neo-Darwinist bent exhibits a paradoxically anti-human enthusiasm for killing, viz. the unwanted unborn and the sickly under the guise of such euphemistic misnomers as "abortion" or "euthanasia".

1647 In [Webb76] p. 417 et seqq. is found a similar interpretation of the counterculture and "New Left" of the 60s with its ideas of "liberation" as a kind of "secular Gnosticism", which largely sprang from the occultist traditions of "illuminated politics", i.e. the blend of occultism and politics "that has a religious complexion and obeys a transcendental scale of values": "In this century, with the presentation of traditional religious positions in secular form, there has emerged a secular Gnosticism beside the other great secular religions–the mystical union of Fascism, the apocalypse of Marxist dialectic, the Earthly City of social democracy." Cf. also the analysis in [Lind95], [Lind99], [Nort89], and [AW01] p. 112 et seqq. [Topi71] p. 261 et seqq. investigates the gnostic background of Marxism, whereas [Stro97b] does the same for National Socialism.

Voegelin's scheme has, of course, met with criticism from different quarters, chiefly since it, as should be clear also from the extremely simplified account given above, valorises the purportedly 'gnostic' thought structures very negatively, which hardly will be palatable to all and, in particular, not to those who sympathise with what Voegelin censures, but also because of various historically, philologically, philosophically, or theologically contentious or problematical interpretations and statements of his.[1648] We may, of course, if we so wish, soften or remove his valorisations as well as the not altogether happy term 'gnosticism', thereby possibly making Voegelin's thesis somewhat less controversial while still retaining its valuable explanatory power as to the development of the distinctively Western patterns of thought and the advent of modernity.

In this context it might be elucidating to parallel Voegelin with Karl Popper, as their starting-points and motivations were quite similar, although their conclusions were not: Firstly, they were both exiled Austrian intellectuals, who, having managed to extricate themselves from Austria in the late 30s, came to take an unyielding stance against National Socialism and Communism.[1649] They were both determined to arrive at a deeper understanding of the spiritual roots of the totalitarian lunacy that had betaken Europe at this time, so as to be able to provide the arms needed to combat it competently and eventually perhaps even help in its extirpation.[1650] Similarly to Voegelin's ideas on gnosticism, Popper's theory of falsificationism[1651] was largely motivated by a wish to deal a serious blow to the ideological basis of the totalitarian movements found in such pseudoscientific theories as Marxism, Freudianism, and Darwinism[1652], which, however, seemed to be able to resist any factual and rational criticisms, however disastrous, by all kinds of questionable techniques and tricks.[1653] Just like Voegelin, Popper was deeply critical of scientism and positivism and his theory of falsification challenged the positivistic theory of verification, although he also shared the positivists' awe of science and technology.[1654] The theory of 'interactionism', which he worked out together with the neurophysiologist Sir John Eccles, seems, to some extent at least, to be of a purport similar to Voegelin's theories on consciousness, viz. to challenge epiphenomenalist reductionism and kindred simplistic materialistic interpretations of consciousness.[1655] But whereas Voegelin wanted to combat the 'gnostic' pseudosciences and *ersatz* religions and defend the classical-Christian basis of Western civilisation with a Romantic, contemplative mysticism based on an intriguing blend of his own somewhat idiosyncratic interpretations of Platonism and the Christian religion, Popper, who seems to have had very little interest in religion and spirituality and rather was a child of the Enlightenment rationalism than a mystic, made Plato the originator of all totalitarian ideas and the archenemy of the "open society".[1656] Although, as yet at least, Popper's influence doubtless has been greater than Voegelin's, his theories and historical interpretations, suffering from the usual spiritual purblind-

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[1648] The pompous, pedantic, and peevish criticisms of the usually sensible scholar Wouter Hanegraaff in [Hane95] p. 29 et seqq., evidently motivated by his own lack of sympathy for Voegelin's political and religious outlook and anti-gnostic polemics, provide one example of this kind of reaction. A more discerning critique is put forward by Eugene Webb in [Webb97a], to which a few scholarly responses of note were also published in subsequent issues of *Voegelin -- Research News*. Voegelin's very negative appraisal of the gnostic mindset and distaste for all kinds of murderous totalitarian ideologies, such as Nazism and Communism, was conditioned by his own experiences in Nazi Austria, from which he managed to flee by the skin of his teeth in 1938. Although the use of such strong language as Voegelin's may seem to lead into a breakdown of civil discourse that will not be pleasant to the more irenic and gingerly of us (including the present author), Voegelin's firm, albeit at times ruthlessly outspoken, stance against all kinds of barbarism commands respect and more so than the feckless opportunism, political correctness, and willingness to cry with the pack typical of too many academics, to whom it never seems to occur that the ideas they toy with so gleefully may have consequences in the real world, that Auschwitz, Gulag, and the Killing Fields are, in fact, the ultimate corollary of some of their pet ideas.

[1649] See [Popp76] p. 107 et seqq. and [Voeg96] p. 42 et seqq.

[1650] This was, of course, a pre-occupation they shared with many other prominent German and Austrian thinkers of this generation, such as Karl Jaspers, Karl Löwith, Leo Strauss, Hannah Arendt, and J. H. W. Rosteutscher, just to name a few.

[1651] [Popp92]

[1652] See [Popp76]. As for Darwinism, Popper seems to have been rather ambivalent. See id. op. p. 167 et seqq.

[1653] See also [Baum88] on the immunity to rational criticism of these theories. As pointed out by Feyerabend and Kuhn, Popper's famous demarcation criterion of falsifiability does not accord well with how science works in reality and would, if applied, by all plausibility be as disastrous to scientific research as the verifiability criterion of the logical positivists.

[1654] Popper's criticism of scientism and 'historicism' in [Popp61] became together with that of Hayek's in [Haye64] extremely influential. For a critical assessment of positivism by Voegelin, see [Voeg48] and [Voeg87] p. 3 et seqq.

[1655] See [PE81] and [Voeg90]. Although somewhat similar in intent, Popper's and Voegelin's theories of consciousness are of course very different both in their details and their general character.

[1656] [Popp50]

ness of modernist thought, lack the depth of Voegelin's penetrating and probing historical analyses and, in comparison, tend to appear as well-meant and able, but somewhat shallow and lacklustre rationalistic constructions. In this disquisition, Popper will have to put up with doing yeoman service as a foil to Voegelin, so as to clarify the impulses behind Voegelin's thought and soften the conceivably somewhat shocking impression that Voegelin's uncompromising approach to history and harsh language may make on tender souls when first lit upon.

Below I will attempt to show that, although Voegelin's ideas admittedly need to be supplemented and modified in some respects, his basic approach to intellectual history, the general drift of his analysis of the thought structures that have acted as the driving forces of Western history, and, in particular, his concept of *immanentisation* will be invaluable to anyone, who wishes to gain a deeper understanding of which the distinctive characteristics of Western 'technoscientific' culture are, so remarkably setting it apart from all other cultures, why strange and obvious distortions of reality, such as those mentioned in the previous sections, constitute an integral part of the worldview of our civilisation and can only be unmasked by considerable commitment and effort, and how and why these characteristics and distortions have come into existence and developed their current firm grip on us.[1657] In an interesting essay published some years ago, Eugene Webb, himself a leading Voegelin scholar, criticises Voegelin's use of the metaphors of pathology and health as "an uncritical involvement in the widespread medicalizing tendency of twentieth-century intellectual culture".[1658] In the present study, I will take a stance fundamentally opposed to Webb's denouncement of medical imagery, making the pathological nature of modern Western culture the presupposition of the analysis I will attempt and the very crux to be explained. Although this pathology seems to me so conspicuous and self-evident that only a mole would be able to deny it, I will, in due time, try to pinpoint some of the most perspicuous of its symptoms. Additionally, I do take issue with the veiled nihilism in Webb's statement, insofar as it seems to indicate that we, in the name of holy tolerance, must not attempt the discerning of spirits or prescinding of sound spirituality from pathological – I would even contend that the unarresting commonplaceness of such opinions is *per se* a symptom and proof of the profoundly pathological nature of modernity and its attitudes and platitudes!

[1657] Cf. [Nire96] p. 3 et seqq. for a challenging discussion about the relationship between such general "structures" or "discourses" traceable over the *longue durée* and the use that is made of them by individuals and groups in specific historical contexts through "processes of barter and negotiation".

[1658] [Webb97a]. However, Webb seems to mean that this medical imagery is not entirely unjustified either, but that Voegelin's criteria of spiritual health and disease should have been more carefully worked out. Cf. also [Jame79] p. 92 et seqq. and [Gay93].

> *History has meaning only if it is going to come to an end.*
>
> *Nikolai Berdyaev*[1659]

Historical accounts no less than other human intellectual endeavours are underpinned and pre-determined by metaphysical presuppositions and predilections that only seldom will be explicitly stated and justified and frequently will not even be recognised as such by the ones who espouse them. For one thing, the historian brings his own set of presuppositions to bear on the past when he selects his subject-matter and general point of view and then picks out from an often overwhelming amount of data at hand the information he deems trustworthy and noteworthy, giving assent to some pieces of intelligence, while rejecting others. For example, most pre-modern historical accounts abound with stories of miraculous events, by which the modern historian generally sets little store regardless of the quality of these accounts, whereas he blithely rests assured that he will be able to sift out from these selfsame works other pieces of information which he can trust, thereby unawares paying allegiance to Hume's and the naturalists' assertion that miracles cannot happen, usually without the slightest shred of proof, reflection, or discussion about the matter – and thereby also superciliously rendering the chroniclers of yore gullible, unenlightened dupes, from whom the facts of "wie es eigentlich gewesen ist" are to be brutally squeezed by us in the know, rather than valuable insight and wisdom respectfully gained, to which we, perhaps, have been lost as a consequence of our devious ways and the spiritual darkness of our own benighted times.[1660]

Additionally, the historical data at hand, vast or not, will never *per se* be enough to create a coherent, comprehensible, and interesting historical account, since so many of the crucial pieces, and not only men's thoughts, conversations, and ulterior motifs or the secret cabals they may have been privy to, but most notably the *driving forces* behind the events and the *significance* of them, are not directly accessible through the primary sources, thus compelling the historian to supplement what is lacking by weaving the bald historical data into an ornate web of meaning of his own design and making. Consequently, historical narratives are always to a large extent *mythistorical,* providing a mirror of ourselves, of our times, and our concerns no less than of days gone by. Significantly, we cannot reach behind the available sources to check the validity of these mythistorical structures and re-enact "wie es eigentlich gewesen ist" in the way a scientist tests a hypothesis by experiments, although this observation should not be taken to imply that we should indulge in unrestricted historical relativism, as, for example some postmodernists do, averring that there is no such thing as historical truth, or that we cannot bring in a well-founded verdict on many issues of fact by meticulous study and clever argumentation. Nonetheless, historical accounts are fundamentally shaped by mythical and narrative paradigms that have taken on a life of their own as structures and shaping forces in the consciousness of mankind. For one thing, anyone who, like Voegelin, tries to come to terms with the history of the *longue durée* in order to find out its plot[1661], pattern, or meaning must first of all ask where to begin the account in order to find the proper *starting-point.*[1662] As it turns out, the choice of starting-point and the colouring and nuances in which the

[1659] Quoted from [Cost93] p. 213.

[1660] Cf. [Bell91] p. 2 et seqq.

[1661] Cf. [McPh01].

[1662] In [Elia71] p. 139 et seqq., Mircea Eliade points out that in traditional societies, with their typical orientation towards the supramundane, worldly history, albeit often endowed with significance in terms of some transcendental cyclical or eschatological scheme, is not valued *per se,* but is looked upon negatively as something to be endured, whereas modern man, having embraced a wholly innerworldly conception of the cosmos, shorn of such transcendental implications, becomes a prey to "the terror of history", which compels him to try to extricate from the events of history whatever innerworldly meaning he can find in them. Thus metahistory, macrohistory, comparative history, and historiosophy will become prominent, largely acting as a kind of secular theology or surrogate of the transcendental, not seldom in the form of an immanentised salvational history or *Heilsgeschichte* (see [Löwi53]; cf. also [Taub91], [Bult57], and [Piep99]). This will be especially conspicuous in the progressivist tendencies amongst the older metahistorians, such as Vico, Voltaire, Lessing, Herder, Condorcet, Comte, Hegel, Marx, Spencer, and Darwin (see [Whit73] and [Ross84]). Cf. also footnote 1621 on p. 335.

As the credibility of the story of progress gradually palled during the latter part of the 19th and the former part of the 20th century, the leading metahistorians instead tended to turn to cyclical approaches. Such systems were worked out by Oswald Spengler, whose brilliant [Spen97], *Der Untergang des Abendlandes,* seems to have experienced something of a renaissance lately (cf. [Ludz80], [Fisc89], [Farr01], and [Wrig96] p. 135 et seqq.), Arnold Toynbee, whose multi-volume *A Study of History* (see [Toyn34] in 12 volumes or the more accessible

starting-point is portrayed will be very telling as to the general drift of the metaphysics implicit in the historical account and in the structural forces shaping the account.

Before the onslaught of secularist, anti-Christian philosophy commencing during the Renaissance, macro-historical narratives were generally staged on the basis of a Biblical-Christian interpretation of the grand pattern of history.[1663] Although this well-known construal of the past, arguably reaching its apex with Bos-suet's *Discours sur l'histoire universelle,* cannot and need not be restated at length here, it will be worthwhile to briefly recapitulate its main points. Firstly, in this conception, the ***starting-point*** of history is of course God's creation of the world, heavens and earth, plants, animals, fish, and fowl, and, finally, man, whereupon follows the first couple's sojourn in Paradise, where they, for a time, dwell in a state of primordial felicity, communing with their Creator directly and intimately. Tempted by the enigmatic serpent, they, however, commit the original sin of eating the fruit of "the tree of the knowledge of good and evil", thereby occasioning their own expulsion from the paradisiacal bliss as well as God's curse over the earth. After this fateful event, "the Fall of Man", being the cause of death and innumerable other ills unto man, the antediluvian drama of the rapid deterioration of the state of affairs on earth through man's sinfulness and the machinations of the fallen angels and their prodigious offspring supervenes, leading up to the Flood, by which God put an end to all this deplorable depravity and chaos, saving only Noah, his nearest kin, and a few specimina of each kind of the created beings so as to make it possible to restore the creation to a somewhat more passable state.

After the Flood, God makes a covenant with Noah and the other living beings, whereby the character of history is fundamentally changed and history takes on the form of *Heilsgeschichte,* a story of salvation, in which God works towards the ultimate goal of the restoration of mankind and the Creation. In accordance with the

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one-volume summary [Toyn88]) has been very variously appreciated (see, for example, [GTS49], [Ande55], [Ashl56], [Garg61], [McNe89], and [Wrig96] p. 135 et seqq.), and Pitirim Sorokin, whose *Social and Cultural Dynamics* (four-volume edition [Soro37] and the abridged edition [Soro70]) has also retained a certain popularity (see, for instance, [Brow96b]). Besides these cyclicalist luminaries, whose impact on contemporary thought has been far-reaching, as has Voegelin's through his chef-d'oeuvre *Order and History* and his other works, there are numerous more or less well-known 20th-century metahistorians and historiosophers, of whom some of the more influential will be Berdyaev (see [Berd90]), Dawson (see [Daws], [Daws58], [Daws62], [Daws28], and [Daws56]), Jaspers (see [Jasp49]), Mumford (see [Mumf55], [Mumf40], [Mumf44], [Mumf52], [Mumf57], and [Mumf67]), Kroeber (see [Kroe44], [Kroe62], and [Kroe63]), Rust (see [Rust47]), Bagby (see Bagb58]), Coulborn (see [Coul69]), Quigley (see [Quig79]), van Leeuwen (see [Leeu64]), McNeill (see [McNe63] and [McNe79]), Fukuyama (see [Fuku92]), and Huntington (see [Hunt96]). In addition, [DArc59], [Soro63], [Marc67], [Dani68], [Melk69], [Mont72], [Mont75], [Munz77], [Bebb00], [Bark82], [Cost93], [Nash98], and [Bran98] provide useful overviews and analyses of the theories of a large number macrohistorians, whereas [Stad49], [Ashl56], [MR75], [McIn77], [MS87], [MWZ95], and [Sand95b] are useful collections of papers. Cf. also [Ande64] and [Braw94a] p. 35 et seqq. Surveys of the historical fluctuations between a cyclical, linear, and mixed conception of history are found in [Manu65] and [Soro37] vol. II p. 351 et seqq.

In the mid-20th century, Hayek's and Popper's criticisms against *historicism,* by which term they designated any attempt to find law-like regularities in history in the way attempted by, for example, Marxists and some positivistic historians, carried the day (see [Haye64] and [Popp61]; cf. also [Wilk78] for a critique of Popper), although, indeed, these criticisms were little more than a re-statement of the standard neo-Kantian distinction between *idiographic Geisteswissenschaft,* concerned with "das Einmalige", and *nomothetic Naturwissenschaft,* concerned with repeatable processes. As exemplified by C. S. Lewis' definition of historicism – cited and endorsed by [Ivan91a] – as the "belief that men can, by the use of their natural powers, discover an inner meaning in the historical process", these strictures can be enlarged into a more general scepticism of the notion of the master historiosopher, who, like some ancient soothsayer, is able to, by his learning and intellectual acuity, descry the pattern behind history and, perhaps, in oracular saws prophesy about its further course as well. As amply testified by the shifts in the history of historiography, the inner meaning of history remains one of God's more well-kept secrets, which many have vaingloriously believed themselves able to unveil, when they really only have implicated themselves in the kind of dangerous delusion men of old would have construed as the rightful punishment of God for their impious insipience and hubristic ambition. Even those of us who revere the supposition that God has given an outline of His salvational plan in the eschatological parts of the Holy Writ have to admit that the correct interpretation hereof is extremely tricky, if not beyond the ken of man, as verified by both the enthusiasts' and the scholars' persistent failure to wrangle valid dates and identities from the prophetic utterances. Our own account below is thus only to be understood as a 'probable story' and a provisional sketch of a sketch, motivated by our own wish to regain something of the truth and balance of history by providing a countervailing picture to the in our view tremendously lopsided and propagandistically distorted macrohistorical constructions currently prevalent or taken for granted. As will become clear, I also – like, for example, C. S. Lewis or Hans-Georg Gadamer (on the latter see [Lübe87] p. 174 et seqq.) – disapprove of the cavalierly chronocentric and historicist kind of historiography, in which authors and thinkers of other times are rendered irrelevant by being construed as wholly determined by their own times, whereas the historian himself, somehow wondrously removed from such temporal conditioning and his own *historicity* (on this concept, see [Lübe88] p. 231 et seq.), comes out as a kind of unapproachable *arbiter elegantiarum* of history. Far from being irrelevant or naïve, the dead masters, I contend, can help us to gain a proper perspective on ourselves and our own times and to come to our senses again from our present spiritual stupor.

1663 Attempts to analyse how and why the Christian interpretation of history segued into the modern, secular one are provided by [Löwi49], [Löwi53], [Ross84], and [Funk86] p. 202 et seqq.

promise given to Abraham that "in thee shall all families of the earth be blessed",[1664] it turns out that the restoration will happen through the Jews, "the chosen people", and through the coming amongst them of a Saviour, the Messiah or Christ[1665], who, at the end of time, will judge men – including the resurrected dead – after their deeds, fight a final battle against the evil forces, and restore the righteous to a new kind of paradisiacal state, the New Jerusalem. In this conception of history, which *mutatis mutandis* is common to all the Abrahamitic religions and, leastwise partly, prevalent also in, for example, Zoroastrianism, Manichaeism, some varieties of Hinduism and Buddhism, and Tibetan religion[1666], the great breakpoint in history obviously is the appearance of the Saviour, through whom the restoration of mankind will be brought about. In the specifically Christian understanding of salvational history, the Messiah or "Son of Man", who Himself is God, has already been born and has lived for a time on earth as Jesus of Nazareth so as to expiate through His suffering on the Cross the guilt incident to mankind due to the original sin, defeat by His Resurrection the power of death, and set the process of mankind's renovation going through the reform of man's heart under the guidance of the Christian gospel, the Holy Ghost, and the Christian Church founded by Himself through His apostles. Only at His Second Coming at the end of time, the aforementioned final apocalyptic events are expected to ensue.

Since the Enlightenment it has instead been customary to skip Biblical history and let history start with the Greeks, although there has, of course, never been any dearth of painstaking and scrupulous macro-historians, who have taken the alternative route of letting the narrative set out with the establishment of the great Oriental high cultures or in some "prehistoric", barbaric era, a shadowy Neolithicum or Palaeolithicum,

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[1664] *Gen. 12:3.* See also *Gen. 18:18,* where it is said, "all the nations of the earth shall be blessed in him".

[1665] The Christian exegetes spotted a first prophetic hint of the coming of Christ already in the *protevangelium* of *Gen. 3:15:* "And I will put enmity between thee and the woman, and between thy seed and her seed; it shall bruise thy head, and thou shalt bruise his heel."

[1666] See [Abeg28]. Iranian religion with its conception of the Messianic *Saoshyant* (saviour) and the coming *frashkart* (transfiguration) of the world has often been made the cradle of all Messianism by modern scholars of religion – and especially by those of the *Religionsgeschichtliche Schule* so prominent in early 20th century Germany –, apparently all the more eager to make this derivation as it seems to undercut what they perceive as the foundation of the Christian religion. For example, [Cohn93] tries, on the foundation of various studies such as [Hinn69] or [Hinn74], to unload on Zoroastrianism the brunt of the blame for the Messianism, of which he so strongly disapproves, apparently believing it to be the ultimate source of anti-Semitism, the Holocaust, and most other evils of the world, but into the bargain manages to render the religion of the Jews a rather pointless and narrow-mindedly legalistic cult of the Jewish people itself. In point of fact, this neo-Sadducean theory of a late, intertestamental Iranisation of the Jewish religion, perverting the original purely nomocratic Mosaicism is fraught with problems. For one thing, there is already in the *Pentateuch* a good deal of these purportedly Iranian features, for example i) in various intriguing features of the Genesis account of the Creation and the early history of the world, including the *six* creation days paralleling the *six* Amesha Spentas of Zoroastrianism (Ahura Mazda's archangels, commonly conceived of as the representatives of different aspects of his being), the duplicate creation of man paralleling the Zoroastrian *menog-getig* antinomy (see footnote 1559 on p. 320), and the appearance of the serpent as an evil force opposed to the will of God, similar to the Zoroastrian Ahriman, ii) in the – *pace* the assertions of the pan-Iranists to the contrary – reasonably pervasive presence of angels and demons herein, and iii) in the Messianic eschatology implicit in many passages such as in the already cited *Gen. 12:3* – God's promise to Abraham that "in thee shall all families of the earth be blessed" – as well as iv) in the implicit point of the entire drama of God's action with the recalcitrant people chosen by Him not because of their own merits and to their own advantage, as they themselves would have it, but in spite of their repeated trespasses and only so as to have them serve as the cat's-paw of the, as yet only obliquely described, objective of the divine will – that is to say the grand plan of the restoration and regeneration of the fallen postlapsarian world to its prelapsarian perfection. That this is so, is also strongly suggested by the emphasis put to the moral failings of the Jewish people and their patriarchs throughout the *Pentateuch,* being an inexplicable anomaly in the narrow 'Sadducean' construal, but rendered comprehensible in the light of the grand plan of divine economy, where the Noachian, Abrahamitic, and Mosaic covenants are but provisional arrangements reflecting the imperfections of the postlapsarian world and the final restoration of man and the world remains a distant, future goal of the divine actions.

Much like the analytical school of Homeric scholarship, the Biblical scholars working from the premises of pan-Iranianism and the allied 'document hypothesis', which by dissolving the Biblical narratives into a plethora of snippets then to be derived from various imaginary sources on all kinds of arbitrary grounds makes it possible to reject any anomaly or difficulty as an interpolation, seem to contract a strange myopia, which makes them blench at the basic unity of the studied works, their closely knit compositional structure, the grand plot that emerges from them, and their specific purposes and individual characters, which mostly provide much more natural explanations of why this or that belief found in one work may seem to be absent or of secondary importance in others than the hypotheses of religious evolution or extrinsic influences. As far as the Iranian hypothesis is concerned, it will also be extremely difficult, if not utterly impracticable and futile, to tell which ideas derive from where in the extremely complex religious-intellectual ferment that is early Near East history and pre-history, and the pan-Iranist explanation rests on a particularly shaky ground, as almost all written sources of Zoroastrian religion are very late, mostly taken down in writing only during the Middle Ages or, at best, late Antiquity, when Persia long since seethed with Christian, Jewish, Moslem, and Manichaean ideas. The extreme disarray in scholarly opinion on the history of Iranian religion is well illustrated by the research survey in [Jong97]. The ideas of the *Religionsgeschichtliche Schule* were largely upended by [Colp61] and have now generally been abandoned for somewhat less freewheelingly speculative theories; cf. also [Yama90] p. 458 et seqq. et passim, [Holz94], and [Culi83] p. 16.

from which man's progressive march towards higher and higher stages of "civilisation" by means of "evolution" could be spectacularly envisaged. Although this is also to a certain extent the approach of Voegelin in his magnum opus *Order and History,* where the first volume starts with an account of the "cosmological order" of the ancient Near East civilisations of Mesopotamia, Persia, and Egypt, the emphasis of this volume, aptly entitled *Israel and Revelation,* lies on the analysis of the challenge presented to these cultures by the emergence of the Israeli nation with its radical monotheism, "pneumatic theophany", and notion of "historical order".[1667] Notably, the almost boundless innovative importance conventionally attached to Greek thought since the 18th century has lately become the subject of heated debate, as have the Greeks' interrelations to and possible dependencies on the intellectual life of various other cultures.[1668] Here, the compass of "other cultures" need not be limited to Egypt, Persia, and the Near East only, but can – with fascinating results – be extended to a much more comprehensive Eurasian-African vista.[1669] Additionally, all since Karl Meuli's pioneering work in the 30s there has been a growing appreciation of the crucial rôle played by the age-old phenomenon of "shamanism" in the gestation of Greek philosophy.[1670] Presently, the meticulous macrohistorian may, thus, well opt for the occurrence of written sources as the most reasonable criterion of where to start, as very little can be known for sure – besides the bald facts of the archaeological and mythological vestiges themselves – about the course of the history of the shadowy *Urzeit* that preceded such records, unless one is ready to set much store by the various slippery interpretations and extrapolations derived from archaeology, projective anthropology, palaeontology, and comparative mythology, to say nothing of the farrago of unbounded conjecture and retrocognitive divination touted by the tale-tellers of evolutionary historiosophy and similar speculative approaches. Ironically, this criterion will bring the historian back to the Biblical narrative, through which first emerges a real sense of history based on a concerted recording of its course over an extended period of time as well as on a probing understanding of its inner meaning, and, albeit only to a much lesser extent, the scattered records of the early High Cultures of the Near East, Egypt, India, China, and some other early high cultures.

Additionally, it should be noted that the modern understanding of history, in spite of its secular character, largely has remained determined by the interpretative patterns set down by the Biblical-Christian tradition. The major secular historiosophies, such as Hegelianism, Marxism, positivism, progressivism, evolutionism, etc., all depict history as a progression towards a goal – albeit an innerworldly rather than a transcendental one – a march or struggle towards the happy state of politico-technological bliss at the end of history, nay this

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[1667] [Voeg56] vol. I. It has become something of a commonplace that the sense of history emerged with the Jews, replacing an older cyclical view of time and history with a linear conception. See, for instance, [Elia71].

[1668] Lately, there has been considerable altercation over Martin Bernal's *Black Athena* [Bern87] (see also [Bern01]), a brave, bellicose, and learned, although at times obtrusively contrarian and overly fanciful, attempt to derive the "legacy of Greece" from Egyptian sources, the significance of which had been rather generally acknowledged both by the Greeks themselves, as strikingly testified by, for instance, Plato's *Timaeus* and the second book of Herodotus' history, and the latter-day inheritors of classical culture, most notably in the *prisca theologia* tradition (see [Walk72] and [Ridi95]) until romantic philhellenism and Indo-European linguistics made such views unfashionable. Cf. also [Preu92], [LR96], [Lefk96], [Berl99], and [Glan42]. The impact of Oriental thought on Greek thinking is discussed in [Eisl10], [Corn80], [Hopf25], [RS26], [Duch58], [Afna65], [Burk92], [Momi98], [King95b]; [Götz23] (pseudo-Hippocrates); [West71a] (Pherecydes, Anaximenes, Heraclitus, et al.); [Afna69] (Anaxagoras, the Greek Tragedians, Socrates); [Kers45], [Fest46], [Kost51], [Bide79], and [Clar98] p. 78 et seqq. (Plato), [Luri64] p. 6 et seq. (Democritus); [Webs58] p. 64 et seqq. (epics); and [King95a] p. 217 et seqq. (Empedocles et al.). [Hess55], [Land66], and [Boma70] contrast Hebrew and Greek thought, prophetic faith and Platonist philosophy. Cf. also [Tegg39], an intriguing study of certain correlations between Roman and Chinese history.

[1669] Although a torso, [Plot63] will be the most impressive attempt to date to create a *universal* history of philosophy, establishing the tremendous amount of interaction between the West and the East that has taken place through the ages, all since the era Jaspers called *Achsenzeit* or "the axial age" (see [Jasp49]), i.e. the exceptionally creative period 600-300 B.C (though Jaspers more generously let it span 800-200), when, *inter alia,* Socrates, Plato, and Aristotle in Greece, the later prophets in Israel, Buddha, Mahavira, and the authors of Vedanta in India, Confucius, Lao Tzu (who, however, may not be a historical personality), and Mencius in China, and perhaps Zoroaster in Persia, put together the warp and woof, on which most of the web of ideas of the globe has been woven since. As regards the contentious dating of Zoroaster, see [King90], [Boyc01] p. xiii, and [Clar98] p. 18 et seqq., and [Stoy00] p. 21, who, considering datings that range from 1700 to 600 B.C, seem to think it most likely that Zoroaster lived at about the same time as the Rigveda was authored, thereby suggesting another great wave of creativity, which would encompass Moses, Zoroaster, and the authors of the Rigveda. Amongst the various more concise attempts to write a history of "world philosophy", [Coll98c] and [Smar00] are to be noted. Cf. also [Naka92], [Raju92], [Glas80] p. 256 et seqq. and http://www.sckans.edu/~gray/plott95.html.

[1670] See [Meul35]. However, Meuli's ideas had been foreshadowed already by Rohde in *Psyche* [Rohd21]. On the influence of shamanism on the ancient Greeks, see [Dodd73a], [Lind65], [Culi83], [King95a], and [King99]. Cf. also [Nybe37] on its influence on ancient Iranian religion. On shamanism in general, see [Elia72], [Lewi71], [Hali91], and [Door88], the latter one with an emphasis on "neo-shamanism". A trenchant evangelical critique of shamanism is provided in [AW96] p. 532 et seqq.

conception of history is the constitutive principle behind modernism, "the kingdom of man"[1671] with all its celebration of democracy, science, and technology and its cult of the saintly "heroes", who sacrificed themselves during the struggle for one or other of these pillars of modernity. We have already touched upon and will later come back to the question of how this secularisation of the Christian understanding of history happened.

Thus, it will not only be in a theological perspective that the ministry of Christ and, in particular, His death and Resurrection will stand out as the crucial moment and pivot of world history. With Christ history becomes universalised and oriented towards a single distinct goal, epitomised by the risen Christ's commandment to his disciples to go and teach and baptise all nations.[1672] This commandment, promising to re-unite a regenerate mankind into the Kingdom of God under the auspices of Christ and His Church, provides the obvious counterpoint to the Tower of Babel, through which the world was split up and fragmented in peoples and tongues.[1673] As a consequence of this divine command, history hereafter primarily becomes a matter of the propagation of the Christian gospel and various reactions to the invitation it proffers. These reactions constitute the real meat and bones of the subsequent story of man's spiritual life, surreptitiously shaping it and, like the unseen hand at Belshazzar's feast, leaving its marks on the walls of all the houses of thought constructed ever since, be they Christian or not. Thus, it will not be unreasonable to choose the appearance of Christ as the most appropriate starting-point of the present exploration of history.

But before starting this exploration, another pattern of human consciousness also appropriated from Jewish-Christian *Heilsgeschichte* must be considered, to wit the notion of the Fall, the turning-point in history, at which things all at once changed for the worse. This notion tends to colour not only man's understanding of history, but also his overall outlook in the most decisive manner.

3.3.2.1 The Lapsarian Imperative

> *The vast and shallow philosophies, the huge syntheses of humbug, all talk about ages and evolution and ultimate developments. The true philosophy is concerned with the instant.*
>
> *G.K. Chesterton*[1674]

At most points of history, the impression pressing itself upon the student of the state of the world has been, if not appalling, at least miserable. Although it can hardly be denied that the plight of mankind indeed seems more inauspicious and calamitous than ever today, the sense of crisis is not new. But for some short spells of – mostly wholly unwarranted – optimism, the sense of crisis and imminent gloom has followed man through the ages, although the preferred diagnosis has changed considerably over time. Whether one holds that God made man in his image, nature engendered him through some Darwinist whim, or some world soul or collective unconscious conjured him up through a mind-boggling act of prestidigitation or emanation, man obviously no longer lives in the primordial environment for which he was, in some sense, pre-eminently well-designed and well-adapted, but in a secondary world, which, albeit largely of his own making, tends to depart further and further from the primordial state, whatever this is assumed to have been. To the probing mind, some step or other in this long process of alienation may take on a particularly ominous and critical quality. Taking their cue from the *Genesis* account of how man's current plight was caused by his fall in the Garden of Eden – or, perhaps ultimately, by a preceding, pre-Adamite fall of Lucifer and the other rebelling angels of the dark[1675]–, many thinkers throughout history, aghast at the woes of their own time, have attempted to identify a

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[1671] The term "the rule of man", "människoriket", was used by Tage Lindbom to denote the innerworldly goals of the modern project in contrast to the otherworldly kingdom of God that was the goal of pre-modern Christianity. See [Lind78c], [Lind79], and [Lind95].

[1672] *Ev. Matt. 28:18-20*

[1673] [Bors95]

[1674] [Ches1908] p. 233

[1675] Albeit biased in its interpretations, [Tenn68] contains much valuable material on the doctrine of the fall. Cf. also [Illi75], [Will48] p. 112 et seqq., and [Hein95] p. 81 et seqq.

kind of fall, a peripety in history, when things started to go seriously awry. As a typological tool in classifying the many suggestions made about such peripeties, which, just like the choice of starting-point, tend to be exceptionally revealing as for their authors' metaphysical presuppositions and preferences and other deeply held convictions, I should like to suggest these terms:

- *The Secondary Fall* is a certain key event or turning-point in history which, being exceedingly far-reaching in its consequences, is construed as the explanation of the present ills. The general inclination to find such decisive turning-points for the worse in history does not necessarily imply that the idea of the Edenic Fall and the Christian project to undo it is given up, although it may indeed weaken, undermine, or supplant it.

- *The Fall of Christianity.* In this variant of fall stories, which has always enjoyed considerable popularity amongst Christian malcontents – being cherished, for example, by the Protestant Reformers, Eastern Orthodox critics of Roman Catholicism, many Christian sects, and Christian Platonists and New Agers –, some event in the history of the Church is declared the Great Fall of the Church, vitiating and distorting genuine Christianity beyond recognition.[1676]

- *The Inverted Fall.* This fall story, which seems to have originated amongst the ancient Gnostics, in particular the serpent-worshipping sect of the Ophites, has had some of its most eloquent proponents amongst modern progressivists, such as Kant, Hegel, and Schiller.[1677] It inverts the meaning of the Fall of Man by making the serpent the great hero, who liberates man from a lowly, unenlightened state of ignorance, and by celebrating Adam's and Eve's act of disobedience to God as man's coming of age. In this story, the onset of Christianity, and in particular of orthodox Christianity, will inaugurate "the Dark Age", when the doctrine favoured by the inverters, be it Greek rationalism, philosophical atheism, Platonism, perennial wisdom, ancient paganism, Gnosticism, or something else, was unduly supplanted. This revisionist, frankly anti-Christian interpretation of history has gained in popularity all since the Renaissance, apparently growing more and more viciously Christianity-hating over time.

Contemplating the current predicament of the Earth, a present-day inquirer may opine that the modern project has come into a formidable cul-de-sac, having brought forth utter spiritual disorientation, the break-down of traditional religion, philosophy, and all value systems, unmanageable environmental and overpopulation problems, the terrors of modern warfare, third-world pauperism and seemingly endless starvation catastrophes – regularly broadcast as a kind of shocking divertissement to a global circus audience thirsty for blood and horror –, the hideous disfiguration of landscapes and townscapes, ever-increasing fears for a coming technocalypse, a general cultural degeneration articulated in the soulless and dismal character of modern architecture, art, and literature – to say nothing of the hapless state of popular entertainment characterised by cynical and tawdry sensationalism –, and consequential widespread sentiments of ennui, inanity, and the futility and superficiality of the modern mode of existence with its seemingly purposeless rat races and treadmills, interrupted only by hysterical stints of escapist amusements and rapturous consumerism, – just to name some of the unpalatable dishes on the table made by modernism. Hereupon, our inquirer will possibly be inclined to conclude that, all things considered, this renders science, technology, and the rationalistic, scientific mind-set underlying modernity not the august and propitious *dei ex machina* they used to be, who, in time, will answer all riddles, resolve all problems, and remove all obstacles, but appalling ghouls, to be

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[1676] Amongst the most popular candidates will be the establishment of a 'professional' hierarchy of clergy in control of the Church at the expense of more lax or democratic forms of control, the purported vitiation of the Church by pagan philosophy, mysticism, asceticism, or some other 'foreign' influence, the apparent decline of the charismatic gifts of the Holy Ghost in post-Apostolic times, the Constantine adoption of Christianity as the state religion of the Roman Empire, the subsequent accumulation of riches and power in the Church and in particular the ascendancy of the papacy to ecclesiastical and/or worldly power, this or that Church Council (ranging from Nicaea in 325 up to Vienne in 1312) or the entire thrust towards dogmatic fixation these councils embodied, the great schisms between i) Catholics and Arians/Nestorians/Monophysites/Origenists etc. in Late Antiquity, ii) Catholics and Eastern Orthodox in the early Middle Ages, and iii) Catholics and Protestants at the Reformation, etc.

[1677] See [Hein95] p. 195.

held guilty of both the current ills and even worse ones yet to come. In such an analysis, the quest for the *secondary fall,* at which the current derailment commenced, becomes almost mandatory.[1678]

[1678] Some such eventful turning-points that have been suggested (or suggest themselves) are:

1. man's renouncement of a supposedly happy primordial state (nowadays, on the basis of anthropological research, often identified with the most 'primitive' food-gatherers' carefree mode of existence; cf. [Hein95] p. 161 et seqq.) through the adoption of customs such as hunting, domestication of animals, tool- and clothes-making, property-owning, and, in particular, the cultivation of the earth, leading to all the well-known evils of a more complex society (such primitivism is usually associated with Rousseau and the Romantics, but has a long history; see [LB35] and [Boas48])
2. the appearance of cities, nations, and empires, the 'megamachines', which enslave their citizens and give rise to the hardships of warfare, state oppression, social conflicts, environmental issues, and many other ills (see e.g. [Mumf67])
3. the introduction of writing, which, according to Plato *(Phdr. 274C-277A, 7 Ep.)* and many later critics of culture, not only changed man's condition, but man himself in fateful and doubtful ways (see *First Book of Enoch LXIX.8-11,* [Have82], [Have86], [Ong88], [Good87], [McLu62]; cf. also [Snel80])
4. the 'Sophistic Enlightenment' of 5th century Greece, giving rise to the kind of shallow, philodoxic rationalism that, by virtue of its skilful use of the magic charms of rhetoric trickery and 'sophistry' to pander to the relativism, egotism, and cynicism always close at hand to those enthralled by worldly power and gain, ever and anon tends to resurface in the history of the Western world, mostly with highly doubtful or dire consequences – the classical condemning verdict on the sophists, going back to Thucydides, Socrates, and Plato, has often been reiterated, but also at times reversed, e.g. in Heidegger's odd criticism of the 'logocentric' (i.e. Socratic-Platonic) turn in ancient Greece from 'being' itself to the, in his view, reprovable search for deeper causes and a theoretical reality behind 'being' (cf. [Kräm59] p. 555)
5. Aristotle's folding of the Platonic ideas into matter, easily leading further onto naturalism, pantheism, or atheism, as seen in many Peripatetics throughout history, from Strato of Lampsacus to Alexander or Aphrodisias, Averroës, and Pomponazzi (cf. [Sher95] p. 7 et seqq. and [Lind99] p. 40 et seqq.)
6. the emergence in the early days of Christianity of various heresies that, just like the rationalism of the Sophists and so much of Greek thought – from which, besides, these doctrines largely can be traced, as argued already by Irenaeus and Hippolytus –, tend to reappear again and again in new guises throughout history (see [Brow84], [Hoga01], [Voeg87], [Voeg97], [Knox61], and [Bell91])
7. the project of building on Earth a Christian *civitas Dei* initiated in late Antiquity by Constantine, albeit from one point of view commendable as a noble and exalted pursuit beneficial to society at large, and also, from another vantage point, inevitable and necessary after the demise of the pagan underpinnings of the Roman empire, nonetheless embroiling the Church in worldly power, wealth, institutionalisation, state authority, and the physical defence of Christianity against outer and inner enemies in deeply ambiguous and problematic ways at the peril of Her own purity, credibility, and integrity, as well as making Her the target of much mundane ambition and intrigue
8. the onset of the 'Faustian' spirit of thisworldly technoscientific progressivism in Western Europe (see [Spen97] p. 234 et seq. et passim, [Fisc69], [Whit67], [Whit78], [Stoc78], [Ovit87], [Whit90a], [PT94] p. 17 et seqq., [Benz89], [Benz65] p. 135 et seqq., and [Nobl99]) – plausibly getting much of its manipulative-exploitative fervour, its *libido dominandi* and *curiositas,* widely perceived as forms of sinful *concupiscentia* in the Middle Ages, from its association with the Hermetic-Islamic black arts and occult lore (see [Hans78], [Hans86], [Newm89], [Kiec89] p. 100 et seqq., [Pete82], [Eamo83], and [Eamo94] p. 38 et seqq. et passim), the moorings to which were not loosened until the 18th century –, first perhaps becoming noticeable amongst the Franks in the 8th-9th centuries through the adoption of the stirrup and various agricultural innovations (so at least [Whit62], but cf. [Sloa94] and [SH63]) and in the Carolingian philosopher Scotus Eriugena's positive reappraisal of the *artes mechanicae* ignored or scornfully dismissed by most earlier commentators, such as Martianus Capella in his popular *De Nuptiis Philologiae et Mercurii* (see [Nobl99] p. 14 et seqq. and [Whit90a] p. 70 et seqq.), from then on growing increasingly influential and obtaining ideological justification both through the ideas of a restoration of man's prelapsarian perfections and position as the master of the creation and through the immanentised eschatology of Joachim of Fiore – themes to be further elaborated and transformed by numerous later utopian theoreticians, such as notably Francis Bacon and Auguste Comte (cf. footnote 1621 on p. 335)
9. the influx of a secularly biased form of Aristotelian philosophy from the Arabs into the West in the High Middle Ages, dissolving the wedlock of spirituality and theology cultivated in the tradition of mystical Christian Platonism from the Fathers to St. Bonaventure and pushing Western philosophy and theology towards an unspiritual and quibbling rationalism, which, despite the efforts of St. Thomas Aquinas, St. Bonaventure, and the other great Schoolmen, ever and anon bred not only philosophical shallowness, but theological duplicity and ambiguity, as perhaps most easily discernible in the Averroist doctrine of the double truth (cf. [Lind95] p. 10 et seq., [Lind99] p. 127 et seqq., [Scha68a], [Corb93] p. 249 et seqq., and [McIn98] p. 62 et seqq.)
10. the Platonic-Hermetic reaction to the secularist tendencies of Aristotelianism – set off by Gemisthos Plethon's and his pupil Bessarion's arrival in Florence in 1438 and the subsequent establishment of the famous Platonic Academy there – midwiving i) modern, mathematically oriented science as a development of the 'Hermetic sciences' astrology, alchemy, and magic, gradually, albeit lingeringly at first, to become the basis also of technology and engineering, ii) a new appreciation of man's rôle in the world derived from the Hermetic notion of man as a mundane god and co-creator, providing ideological support for the technoscientific reconstruction of the world, and greatly conducing to the erosion of the compunction traditionally associated with such activities (Latour's inhibiting "anthropological matrix", as explained on p. 416 below), and iii) the mighty undercurrent of neo-pagan and syncretist mysticism, still to be descried in 'New Age' and kindred strains of thought (see below p. 444 et seq.; cf. also [Wind67])
11. the arrival of the printing press as a major vehicle of religious, philosophical, political, scientific, technological, etc. change (see [McLu62] and [Eise80]; cf. also [McLu94])

There is of course no consensus on the above dismal picture of the state of the world. The modernist ideologies and philosophies as well as their 'postmodern' radicalisations, both being the children of the Enlightenment traditions that still are so pre-dominant in 'public' discourse, fully and wholly embrace modernity, or an even more modern postmodernity. The modernist rhetoric as to the benefits of the modern world, which is said to be uniquely characterised by democracy, freedom, toleration, and rationality, providing everyone with unprecedented comforts and standards of living, the chance to become whatever 'his or her' ambitions suggest to 'him or her', the free and fearless choice of 'his or her' own opinions, political ideas, and religion or non-religion as well as the hope that most problems can be overcome rationally by science, technology, and politics, and suchlike, is too well-known to need presentation, as are the lackadaisical yawns and gestures of the postmodernists. The lapsarian story favoured in such circles, if any at all, will be the one of the inverted fall.

Although tempting to anyone who engages in the kind of pursuit we are up to here, we should avoid falling into Romantic counterhistorical pipe dreams, arguing that if not a certain fateful event, such as the first world war – the great modernist "rites of spring"[1679]– had fortuitously[1680] handed the reins over to the corps of ideologically "possessed" (to borrow Dostoyevsky's apt characterisation), who by dint of their extremism and lunatic fervour brought disaster and devastation over the world, this world and its inhabitants, guided by the beacon of traditional religion and philosophy and the ethical and aesthetic canon inherent therein – and, thus, presumably taking advantage of science and technology with much more discrimination and judiciousness than presently – could have been much better off. On the contrary, what we are concerned with here is not an evaluation of the present historical reality – an otiose undertaking, unless preceded by a meticulous analysis of the structure of reality far beyond the scope of this study –, but the first preparatory, humble steps of an attempt to regain reality and to comprehend why it has been beclouded by all kinds of distortions – and indeed also, why, in this process of beclouding, the bedrock of Christian theology and philo-

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12. the sundering of Christianity through the Reformation (foreboded already by the great schism between Western and Eastern Christianity in 1054 – as well as by its protracted medieval prelude), in turn giving birth to the deeply demoralising religious wars, religious scepticism, and a strengthening of the worldly powers, which tended to foster predominantly practical-instrumental, and at times highly cynical, views of religion as well as of science and philosophy

13. the scientific revolution and the various secularising philosophical developments associated with it, such as Baconianism, the 'mechanical' and 'corpuscular' philosophies, and Cartesian rationalism, through the stark dualism of which arose the "modern constitution" (see p. 416 below), freeing technoscience from the shackles of religious or moral considerations by suspending the "anthropological matrix"(so [Lato93]; cf. also [Mazl93] p. 68 et seqq.) and, largely by virtue of its *nullibism* (Henry More's term for the Cartesian notion of *res cogitans* sans location in space), made the sphere of the *res cogitans,* the soul and the spiritual, appear increasingly subjective and unreal and, thus, an easy victim to materialist obliteration attempts (cf. [Poor78] vol. II p. 121 et seqq. and [Burn81] p. 19 et seqq.)

14. the triumph of the ensuing enthusiasms of free-thinking and libertinism through the 'Enlightenment' establishment of what Tage Lindbom called "människoriket", the rule of man (see[Lind78c] and [Lind95]), based on the three pillars of modernity, viz. science, technology, and the sovereign power of the people, and the concomitant assault on all traditional religion, philosophy, and culture, brought to a first culmination in the horrors of the French Revolution

15. the Industrial Revolution, uprooting the traditional ways of living and, thus, causing mass pauperism and mass despondency, the destruction of nature, and increasingly exploitative and cynical attitudes towards all and everything

16. the Romantic reaction to the Enlightenment and the Industrial Revolution, revitalising Neoplatonism, Hermeticism, neo-paganism, and neo-gnosticism with very dubious consequences (cf. [Urs47], [Rost47], [Tuve82], and [Godw94])

17. the turn towards nihilism in the middle of the 19th century through the "maîtres du soupçon" (see above p. 319 et seq.)

18. the First World War, causing not only unprecedented military destruction, but the final demise of the old regime and the consequential revolutions, which, in turn, begot all the 19th-century horrors of totalitarianism, modernism, etc. (see [Ekst90])

19. the current explosive growth of technology and science, which, having got wholly out of control, will, at least to those of a 'Luddite' disposition, seem to be about to turn the world into an dystopian nightmare or perhaps even bring about a final technocalypse, as the accumulated sinister effects of unrestrained research and technological development – particularly within such bodeful areas as, for example, genetic engineering, ubiquitous computing, virtual reality and 'cyberspace' technology, artificial intelligence, robotics, or nanotechnology – will bring to a pass the prevalent, ever-deepening ethico-religious and environmental crisis (cf. [Mitc94], [Davi98] p. 253 et seqq., [Heim98] p. 33 et seqq., and the multitude of contemporary techno-Cassandras from the anarchist-Rousseauan UNA bomber [Kacz95] to the rueful computer luminaries Bill Joy [Joy00] and Ted Nelson [Nels97a] p. 95 et seqq.)

As can be seen from this somewhat arbitrary and selective pick of suggestions, all but any significant development in the history of mankind can be interpreted as a fateful "fall". Many of these supposed falls will be discussed again below.

[1679] So [Ekst90]; cf. also [Viri00] p. 93 et seqq.

[1680] Cf. [Tayl69]

sophy, upon which our culture was built, embrittled into an empty shell, inside which gestated all the harum-scarum demons of modernity eventually let out by the first world war and now seemingly reigning supreme. Consequently, the above description is to be understood as but a provisional snapshot of widespread sentiments providing the backdrop for what follows rather than a serious and resolute attempt at an evaluation of the gangrene of modernity.[1681]

3.3.3 THREE TEMPTATIONS

> *Blessed is the man that endureth temptation.*
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> *Ep. Jac. 1:12*

At the centre of the ancient Greek understanding of the course of history was a certain metahistorical pattern, providing the foundational theme of many of the greatest of the tragedies authored by the Athenian dramaturges of the 5th century and given meticulous consideration by Herodotus, "the father of history", who presently has most undeservedly been demoted to the rank of a garrulous teller of ludicrous tales, at best admitted to possess a certain "archaic" charm, although his philosophy of history has never been surpassed in profundity and was tacitly adopted and adapted also by Thucydides, the famous chronicler of the Peloponnesian war commonly celebrated as the greatest historian of ancient Greece and possibly of all times. Behind the events of history are, in Herodotus' view, dark spiritual forces at work, gods and demons, being deeply hostile towards man and, in particular, towards excessive success on his account, which will occasion what he famously called "the envy of the gods", **φθόνος θεῶν** *(phthonos theon).* These hostile powers, always being **φθονερόν τε κα□ ταραχῶδες** *(phtoneron te kai tarachodes)*[1682], envious and discommoding, continually tempt and deceive man in various ways, notably by conferring success upon him, thereby trying to entice him into the **ὕβρις**, *hubris* or *pride,* that, by causing their own **ν□μεσις** *(nemesis),* rightful wrath, will give them a pretext for instilling in him **ἄτη** *(ate),* infatuation or benightedness, and, thus, for bringing about his utter downfall in accordance with the well-known saw *"quem deus vult perdere, prius dementat".* The similarities to the Jewish-Christian conception of the **διάβολος**, "the accuser" or devil, who together with his minions – such as the **στοιχε□α τοῦ κόσμου** *(stoicheia tou kosmou),* "the rudiments of the world", or the **ἀρχα□ κα□ □ξουσ□αι** *(archai kai exousiai),* "the principalities and powers", frequently mentioned by St. Paul and other New Testament epistlers –, tempts and deceives man in order to bring about his ruin, are too obvious to need to be expanded on here.[1683]

To fully appreciate Herodotus' interpretative scheme one must also take into consideration that in early Greece – as indeed generally in 'primitive' and pre-modern psychology – mental contingencies somehow out of the ordinary, such as sudden flashes of genius or inspiration, strong impulses, emotions, and ideas, vivid or somehow significant dreams, and different forms of mental disturbances and manias, such as the four varieties described by Plato in *Phaedrus*[1684], today perfunctorily attributed to the "unconscious" or "subconscious" part of man's own psyche – that handy all-in-one pandemonium, unfathomably well-informed creative factotum, and superabundant store of ulterior aetiology[1685] – were usually held to derive from the demonic realm and its

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[1681] Noteworthy recent attempts to assess and analyse modernity from different points of view can be found in [Lind95] p. 150 et seqq., [Wals90] p. 9 et seqq., [Brow96b] p. 1 et seqq., [Quin97] p. 247 et seqq., [OHea99] p. 157 et seqq., [Mali87] p. 73 et seqq., and [Tayl89] p. 495. Cf. also [Bell92], [Soro43], [Guar98b], [John87], [Toul90], [Ekst90], [Bran98], [Gay98], [Conr99], [Blam99], [Barz00], and [Conq01].

[1682] *Hdt. 1.32*

[1683] See [Schl61]. Cf. also footnote 2423 on p. 522 below. Notably, the rôle of "the demon" in, for example, Palladius' *Historia Lausiaca* [Pall12] is more or less the same as in Herodotus and the other ancient Greek authors, to wit to test man by fomenting his vanity and other weaknesses and thus to bring about the downfall of the proud or otherwise peccant.

[1684] See [Dodd73a] p. 64 et seqq. The four Platonic forms of mania are Apollo's prophetic mania, Dionysus' telestic (ritual-orgiastic) mania, the Muses' poetic mania, and Aphrodite's erotic mania.

[1685] [Koes77] p. 147 provides the following apt and witty description of the "unconscious": "The depth-psychologies of men like Nietzsche, Freud, and Jung bore through the shallow crust, but each drove its shafts into one particular direction inhabited by demons of a particular breed. The concept of the unconscious acquired a mystical halo and a clinical odour; it became a kind of Pandora's box, which sceptical psychologists asserted to be empty, while to others it served as a stage-magician's trunk, equipped with a trapdoor underneath and secret drawers."

different powers and beings.[1686] By this reasoning, these powers could be used to account also for the origins of war and strife, all kinds of human follies and felonies, cultural, technical, and other innovations, and various other significant, wondrous, or awe-inspiring phenomena.

Doubtless, Herodotus' and the other early Greek thinkers' idea of 'daimonic' temptation seducing men into *hubris,* upon which follow *ate* and, ultimately, disaster, provides a key insight into the predicament of man and mankind, applicable to the history of nations, religions, and other human pursuits no less than to the life stories of individuals, to the course of macrohistory as well as to that of microhistory. Interestingly, the theme of demonic temptation frequently appears in the narratives of the life of famous religious figures, also of quite different cultures – so we hear, for instance, of the temptation of both Zoroaster and Buddha.

In Christianity, temptation is of course a notion of paramount import and every Christian in the Lord's Prayer implores God not to lead him into temptation. Many of the great Christian saints had to endure the most hideous and exacting trials of temptation, as though holiness immediately called forth the intemperate envy and ill will of all the hosts of darkness. Also Christ Himself had to go through such an ordeal, as He after His baptism was "led by the Spirit into the wilderness", where He was tempted by the devil for no less than forty days during which time He ate nothing.[1687] The first temptation thus naturally concerns the most basic of human needs, viz. food:

> *And the devil said unto him, If thou be the Son of God, command this stone that it be made bread. And Jesus answered him, saying, It is written, That man shall not live by bread alone, but by every word of God.*

Thus, Christ refuses to give in to hunger and use his supernatural powers to gratify his own desire, but instead refers to "every word of God" as another, and implicitly more important, source of life, which here arguably is to be understood as the "eternal life" of the Christians, rather than just corporeal existence. In the second temptation, the devil tries to induce Christ into a classical diabolical pact, where worldly riches and power are in the end paid by the vendee's soul.

[1686] See [Snel80], [Brem79], and [Dodd73a]. It should be noted that in ancient Greece, the word "demon" or "daimon" (δα□μων) did not have the lugubrious connotations it later achieved, but simply denoted a lesser divinity or spirit. Throughout history and still today, numerous authors, poets, composers, painters, scientists, mathematicians, and inventors – and particularly the most innovative and famous ones – have been blessed, or bedevilled, by strange, occasionally even psychopathological states of mind, fits, dreams, disorders, and afflictions and can often testify to how they received crucial "inspiration" and ideas from an apparently extrinsic agency, during dissociative or trance-like states – reveries, day-dreaming, hypnagogic states, dreaming, drug-induced states, conjuring, cursorily performing some routine chore, etc. – and not seldom through quite exotic means of transmission, such as automatism, dictation by inner voices, channelling, astral travel, lucid dreams, or visions involving communication with imaginal, 'daimonic' beings such as angels, fairies, spirits, extraterrestrials – [Qvarn59] p. 176 et seqq., [Klim87] p. 162 et seqq., [Krip99a-b], [Hast91] p. 11 et seqq., [Broo01] p. 34, [Tala71] p. 28 et seqq., p. 125 et seqq. et passim, [Mavr87] p. 186 et seqq., [Prin98] p. 194 et seqq., [Ghis52], [Ebon71], [KD87], and [Nopp99] give ample examples hereof, whereas [Prin64] and [Nasa98] present two particularly remarkable case stories. Such experiences and demeanour, frequently being germane to the decisive turning-points in their experiencers' careers as well as in the history of mankind, have, for example, been recorded by or about, just to mention a few famous names, Pythagoras, Parmenides, Socrates, Mohammed, Joachim of Fiore, Raymond Lull, Cusanus, Paracelsus, Descartes, Swedenborg, Condorcet, James Watt, Gauss, Joseph Smith, Marx, Darwin, Wallace, Kekulé von Stradonitz, Mendeleev, Poincaré, Gödel, von Neumann, Einstein, Edison, Tesla, Crowley, Freud, and Jung, whereas many of the pioneers of science, such as Roger Bacon, John Dee, Boyle, and Newton were deeply steeped in occult, alchemical-magical pursuits, which occasionally also involved contacts with otherworldly spiritual beings. Notably, a great number of prominent scientists, inventors, musicians, etc. have been Freemasons, thus participating in quasi-occult Masonic rituals, which may, perhaps, help to trigger dissociative or kindred altered states of mind. The simultaneous, but independent discovery of the same new idea or phenomenon by two or more unrelated researchers, apparently happening rather frequently in the history of ideas and science, may also be noted in this context (see [Ione99] and [LE84]). Cf. also [Luba99] on non-Western conceptions of creativity.

[1687] The quotations will follow the text of *Ev. Luc. 4:1-13*. The story of the temptation is recounted also in *Ev. Matt. 4:1-11* and, in a simplified form, in *Ev. Marc. 1:12-13*.

> *And the devil, taking him up into an high mountain, shewed unto him all the kingdoms of the world in a moment of time. And the devil said unto him, All this power will I give thee, and the glory of them: for that is delivered unto me; and to whomsoever I will give it. If thou therefore wilt worship me, all shall be thine. And Jesus answered and said unto him, Get thee behind me Satan: for it is written, Thou shalt worship the Lord thy God, and him only shalt thou serve.*

Once again, Christ rejects the devil's vile offer out of hand by a Scriptural reference. As Christ has now two times refused to hearken to the inducements of the devil by reference to Scripture, the devil now himself in jest cites the Scripture, trying to seduce Christ into the desire of unusual amusements.

> *And he brought him to Jerusalem, and set him on a pinnacle of the temple, and said unto him, If thou be the Son of God, cast thyself down from hence: For it is written, He shall give his angels charge over thee, to keep thee: And in their hands they shall bear thee up, lest at any time thou dash thy foot against a stone. And Jesus answering said unto him, It is said, Thou shalt not tempt the Lord thy God.*

The third temptation constitutes the climax of the sequence of diabolic cajolery, as recounted by St. Luke[1688], but will also be the most enigmatic of the three. It is couched as an enjoinder to "cast thyself down", a phrase that seems tersely to sum up the allure of all sin ever perpetrated in very few words. A boundless spiritual pride will also be inherent in the action suggested, which naturally leads one's thoughts to the story of Lucifer's fall. The theme of flight will also be widely associated with man's most intrepid endeavours both in the physical and the spiritual world[1689], symbolising an illicit Faustian striving towards what is beyond the pale of man.

There are some interesting features common to all three temptations: Firstly, they are all about the use of some kind of *magic,* i.e. unusual, artificial means to suspend the usual course of the world and wrench God's creation to one's own advantage or enjoyment.[1690] Secondly, they are all concerned with *personal, selfish gains,* not with actions made out of compassion, love, or other noble motives. For one thing, Christ later meritoriously used his supernatural powers to the benefit of others, healing the sick, feeding the hungry, and driving out evil spirits from those plagued by demonic possession. Thirdly, Christ rejects all the devil's offers not by reliance on His own moral sentiments or His own mandate as the Son of God, but by reference to the authority of the Scripture, thereby apparently indicating both the significance He Himself attaches to obedience to God and from what source man should primarily seek guidance as to what constitutes God's will. The point will be that whereas in general much confusion and lack of discernment exist in questions of morality and spirituality, Scripture provides a safe authoritative canon with which man should try to comply in such matters, as indeed always has been taught by the Christian Church.

Although the three temptations were put in Christ's way at a specific moment in time at the beginning of His ministry, they are really universal and timeless. They trouble each several man as he forges ahead through

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[1688] St. Matthew recounts the second and the third temptation in the reverse order. [Eitr24] contends that the temptation of worldly power, located to the height of a mountain, constitutes the natural climax of the story and, thus, should make up the last part of the narrative. Whereas St. Matthew apparently thought likewise, this is in our view far from obvious. Firstly, the devil's frivolous use of scriptural reference seems to make more sense if it appears during the third temptation, as a jest. Secondly, the rather enigmatic, spiritual nature of the third temptation seems to be a more insidious and subtle form of sin than man's omnipresent yearning for power and wealth, thus, as it were, rising the stakes of transgression to a climax. Thirdly, the pinnacle of the Temple of Jerusalem certainly will, at least to anyone raised in a pre-Romantic ambience, be a holier and, thus, worthier situation for the climax of the story than a mere mountaintop. As it seems highly probable that St. Luke wrote his gospel after St. Matthew, who, according to the ancient tradition supported by comparative philological analysis (see [Rile89]), was the first of the Synoptics to commit his gospel to writing, it seems conceivable that St. Luke deliberately chose to adjust the account of St. Matthew, although I will not here speculate about, let alone affect to know his grounds for doing so.

[1689] On the importance of soul travel in ancient religion, see [Culi83].

[1690] See [Eitr24]. Cf. also [Kee89], [Garr89], and [Tamb90] p. 6 et seqq.

life as well as mankind in its entirety as it strays through the ages. Although the devil and his host of minions were abolished by Western rationalism some centuries ago, judging from the course of events they certainly still appear to toil day and night to tempt mankind, foisting the three temptations into all kinds of pursuits, societies, and activities of man, into the life of the nations and civilisations no less than into the business of individuals, families, and companies. It transpires that their labours have indeed not been in vain.

Behold, this child is set for the fall and rising again of many in Israel; and for a sign that shall be spoken against; (Yea, a sword shall pierce through thy own soul also,) that the thoughts of many hearts may be revealed.

Ev. Luc. 2:34-35

Think not that I am come to send peace on earth: I came not to send peace, but a sword.

Ev. Matt. 10:34

Beyond peradventure, Christ's and his disciples' claims were both extraordinary and distressing, demanding of all and everyone that they, in order to salvage their own souls, should forsake the ways of their fathers, all previous religion and moral doctrines, and all reliance on worldly wisdom and cunning – to say nothing of power and riches – for the Christian gospel and 'Kingdom of God'. Being substantiated by Christ's own to all appearances faultless unselfishness, goodness, and holy way of life, by His at the same time adamant and serenely meek, terrifying and hope-instilling, offensive and comforting revelation of the penetralia of man's spiritual and moral predicament and obligations, set forth with the authority of a true Messiah, by His appeal to a transformation of man's ways based on an unmitigated reform of the Heart, by His own disciples' passionate and unworldly, albeit by necessity often imperfect, attempts to comply with the exacting standards of their Lord and the Kingdom of God and to live by His gospel of faith, hope, and love, like angels united in brotherly love within an ambience of abysmal decadence and cynicism, by His own numerous and spectacular miracles and healings as well as the pneumatic charismata and wonders surrounding His disciples' activities, attributed by them to the Holy Ghost – that exotic and mysterious force pervading the doings of the Church –, by the apparent fulfilment of the prophecies and hidden allusions of the Scripture in His life and ministry enthusiastically proclaimed by His disciples, and, finally and foremost, by His paradoxical death on the Cross and at the same time marvellous and scandalous Resurrection from the dead, attested to by the empty tomb and a plethora of seemingly candid and reliable witnesses, these claims commanded a reply, from which there could be no question of an easy escape. Verily, the Christian gospel was and is a sword, which pierces through every man's soul wherever and whenever it is preached, presenting him with a stark choice of either acceptance – faith – or rejection – unbelief, trivialisation, rationalisation, contempt, rebellion, disgust, violent hatred. The vehemence of the reactions to this demanding "enten-eller" can be seen both in the explosive growth of the Christian Church during its first centuries of existence and the recurrent and fierce, but always in the end futile, persecutions of it ever since. After Christ, no aspect or development of man's spiritual and intellectual life can any longer be understood except in the light of this all-polarising choice, Christ or Antichrist. Thus, Whitehead, albeit by no means mistaken in his apt and witty observation that "the safest general characterization of the European philosophical tradition is that it consists of a series of footnotes to Plato" would have spoken with greater insight and acumen, had he made this same assertion about Christ.[1691] After all, few have believed that one cannot choose to disregard or reject Plato with impunity[1692], but, in contrast, disregarding or rejecting Christ is, due to the very nature of the Christian claims and the evidence by which it is supported, always a leap of unfaith that is made at the peril of the leaper's own pierced soul.[1693] One may even be tempted to say that the main objective of Western "philosophical" thought, in particular during the last few hundred years, has been to find the formulas that will make such a leap look as reasonable as possible.

1691 [Whit69] p. 53.

1692 Possibly, we should make an exception for Eudoxus of Cnidus, who reportedly dated Plato 6000 years after Zoroaster, thereby maybe indicating that he indeed thought Plato might be the Saoshyant predicted by the great prophet of Persia. See also [King95b] and [Kost51] p. 25 et seqq.

1693 The precarious character of this stark choice can be seen from the fact that many of the most obdurate nihilists and foes of Christianity in history, including Hegel, Nietzsche, Darwin, Heidegger, and Stalin, started their careers by the study of theology, whereas many others, such as Marx, backslid, apparently often through some kind of dramatic spiritual crisis, from a Christian conviction already during their youth.

Thus, we must now take a little closer look at the various responses to the Christian gospel. Firstly, it should be noted that these responses turn out to differentiate themselves much more complexly than just as a simple acceptance or rejection of the Christian invitation to take part in the Kingdom of God. Here it will be neither possible, nor meaningful to attempt a lengthy or all-inclusive analysis of the wealth of different variants of the reactions that have emerged over time. Instead, I will focus on a few central counts and a few typical forms of such responses, which materialised in late Antiquity, have exerted a lasting influence on Western thought ever since, and seem to have important bearings on the current plight of man.

As pointed out earlier, in the Christian conception of history the present predicament of the world is due to the Fall of man from the primordial grace once enjoyed in the Garden of Eden, but through the coming of the Messiah, Jesus of Nazareth, the recovery of the Paradise symbolised by the New Jerusalem is now imminent, nay has already begun by virtue of the crucified Saviour's victory over Death as manifested in His Resurrection, the establishment of the Kingdom of God in the hearts of those who accept the good news – the gospel – with **π□στις,** faith or trust, and the subsequent outpouring of the Holy Ghost to the betterment of man. After these events, history will in the main, according to this conception, be about two issues: 1) the propagation of the gospel to all the peoples of the world, including also the task of the apologetic defence of the Christian faith against the existing *traditional* religions and philosophies, and 2) the struggle between *orthodoxy,* which is understood as a devotion to the *correct* Christian *faith* based on a scrupulous and unswerving faithfulness to its original contents and import, and *heresy,* which, in contrast denotes all kinds of alterations and distortions of the original faith on the basis of *personal preference* or *choice* **(α□ρεσις),** including selective approval and rejection, additions, excisions, adaptations, deforming re-interpretations, and so on.[1694] By means of some simplification, three main categories of response to the Christian invitation can thus be distinguished, viz. *orthodox acceptance, heretical adaptation,* and *traditionalist rejection* of the gospel. Since orthodoxy was largely formulated in response to the challenge of heresy, as an attempt to protect the integrity of the Christian faith, and since traditionalism, *qua* the rejection of Christianity of every hue, heretic as well as orthodox, is by necessity largely determined by the standpoints it rejects, the heretical response will here be considered first, then orthodoxy, and last of all traditionalism.

[1694] For a deeper perspective on the struggles and the "spirit of raging haste" that followed upon Christ's suffering and death on Golgotha, see [Schl61] p. 49 et seqq.

3.3.4.1 Adaptation – The Birth of Heresy

> *Die Gnosis ist offenbar nicht ein - leicht abtrennbarer - Fremdkörper im Christentum, sondern gehört wesentlich zu ihm.*
>
> *Jörg Büchli*[1695]

Firstly it should be noted that *heresy,* denoting a deviation from the Christian faith as taught by its Founder and laid down in Scripture and the Apostolic tradition of the Church, is a kettle of fish different from both *apostasy,* which signifies the rejection of Christ and the Christian religion by someone who once used to be a believer, and *schism,* which designates the refusal to acknowledge ecclesiastical authority, possibly but not necessarily allied to heretical views. Almost from the very birth of the Christian religion, the Christian Apostles had to fight heretical deformations of the Gospel they preached.[1696] The Epistles of the New Testament abound with admonitions and warnings about various dangerous heretics and schismatics, and in the *Acts of the Apostles* we can follow the birth and early development of some of these, such as the Gnostic sect founded by the Samaritan magician Simon Magus. Later, Christian writers, such as St. Irenaeus, Tertullian, and Hippolytus, composed comprehensive heresiological studies, where they tracked down a large number of heretical meanings, factions, and sects, described their origins and history, and, of course, attempted to refute them. In the fourth century, St. Epiphanius discussed 80 such deviations in his *Panarion,* although 20 of these were pre-Christian, and Philastrius of Brescia at about the same time treated of no less than 128 heresies. The output of heretical, and in particular Gnostic, literature, was also very large, often couched as pseudepigraphic gospels, acts, or apocalypses, spuriously attributed to some Apostle or other well-known Christian personage.[1697]

A number of ideal types of heresies, which tend to recur in new guises throughout history, can be distinguished, including:

- *Judaizing*
- *Enthusiasm*
- *Gnosticism*
- *Rationalism*

Inevitably, the above categories very often overlap and intermix in various ways. For example, some Judaizing sects also exhibit strong Gnostic traits, and the apocalyptic-millenarian speculations typical of enthusiasts were not limited to them, but were rife also amongst Gnostics and Judaizers.

Judaizing was a very early deviation from the Christian mainstream, rooted in the unwillingness amongst some Jewish Christians to give up the observance of the Mosaic Law for the Christian "law of freedom".[1698] More seriously, such conservatism was often combined with the rejection of the divinity of Christ *(psilanthropism).* Although the Judaizing Christians dwindled into insignificance over time[1699], they provided the hotbed from which two of the more vigorous and lasting heresies grew, to wit 1) *Manichaeism,* a dualistic-syncretistic sect, which started life in the 3rd century as a minor splinter group within the *Elcesaites* – itself a secession from the *Ebionites,* the most important Judaizing sect –, but soon grew into a zealously missionary

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[1695] [Büch87] p. 210

[1696] The literature on the various heretical sects, whether written from the point of view of the history of religion or Christian heresiology, is vast. A good Catholic introduction to the subject, including basic definitions, is provided by [Wilh10], and the *Catholic Encyclopedia,* which is available on-line at http://www.newadvent.org, contains excellent, albeit somewhat dated, articles on most heretical sects, as does Hastings' *Encyclopædia of Religion and Ethics.* A more up-to-date Protestant handbook is provided by [Brow84] and a Catholic one by [Hoga01], whereas [Geor95c] provides a modern pro-heretical perspective.

[1697] See [Schn91], [Elli99], and [Robi90].

[1698] On Judaic Christianity, see [Scho49], [Dani58], and [Quis68].

[1699] The Monophysite Coptic Church of Ethiopia retains many Judaizing traits, including the practice of circumcision, the observance of parts of the Mosaic law, the celebration of both the Sabbath and Sunday as holidays, etc.

religion that extended its realm of influence from the coast of the Atlantic to the Pacific shores of China and Vietnam, became the state religion of the Turkic Uigurs, for a period counted St. Augustine amongst its adepts, strongly influenced the Ismaili sects of Islam, and finally vanished only in the 17th century from its last strongholds in China although small communities may have survived in isolated mountainous regions even after that[1700], and 2) *Islam,* which apparently was also much influenced by *Ebionite* beliefs, which it repeats or reflects on various counts.[1701]

Enthusiasm is a somewhat fuzzy term, which primarily is used to denote the derailment of the Christian charisma of prophecy by the negligence of the necessary complement of *discernment,* at times exacerbated into a belief in the enthusiasts' own infallibility and freedom from common moral restrictions and obligations.[1702] In particular, enthusiast sects tend to foster an undiscerning credulity as to the validity of apocalyptic-millenarian prophecies, thereby often leading their adherents into the unedifying game of expecting the Second Coming of Christ to supervene at a certain point in time predicted by their self-appointed prophets. These sects also tend to exhibit a general proclivity for austerity, showing in harsh asceticism and the most unbending moral standards, which often make them appear pitiless, rigidly uncompromising, and sectarian, but occasionally this austerity is suddenly reversed into its own opposite. Frequently, these sects cultivate attitudes of violent, revolutionary rebelliousness and may even encourage self-inflicted martyrdom or suicide. To this day, eruptions of enthusiasm have recurred ever and anon within the Christian world, starting with the ancient Montanists, although similar phenomena occur also outside Christianity, for example amongst the Moslems and the Jews.

Gnosticism, in many ways the archenemy of orthodox Christianity, encompassed a large number of mostly minor sects, factions, and loosely organised groups espousing bewilderingly diverse views, doctrines, and ethical attitudes, albeit predicated on a common, breathtakingly inverted exegesis of the import of the *Genesis* story of the Fall of Man (and indeed of the Christian gospel), to wit the supposition that men, or at least some particularly pneumatically endowed men, are capable of saving themselves through *gnosis,* i.e. insight or knowledge (viz. of their own divine origin in the light realm of the *Pleroma* and of the means to regain it) and that sin is to be identified with ignorance (i.e. the lack of this *gnosis),* in short that man is to honour the serpent,

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1700 See [Lieu85], [FB97], [Oort98], [Stoy00] p. 102 et seqq., and [Elia78a] vol. II p. 384 et seqq. The so-called Encratites, "the abstainers", another ascetic Gnostic-Judaizing sect, which refrained from wine, meat, and marriage, may also have made an impact on Mani. Additionally, Bardesanes' Hermetically tinged Christian philosophy is believed to have wielded a certain influence on him (see [Drij66]). Manichaean ideas lived on in the succession of dualistic sects in the Byzantine Empire, Armenia, and in the Balkan states, and elsewhere, such as the Messalinians, Paulicians, and Bogomils, which, in turn, gave birth to the medieval Cathar movements. On the possible influence of Manichaeism on the religion of Tibet, see [Elia78a] vol. III p. 262 et seqq. On the Paulician influence on certain extremist Shiite sects, see [Moos88] p. 435 et seqq.

1701 According to one theory, Mohammed was introduced to the Ebionite doctrine by Waraka ibn Nawfal, the head of an Ebionite community in Mecca and a cousin of Mohammed's first wife, the wealthy widow Khadidja. See [Fahd95] p. 676. Cf. also [Schl18], [Bell68], and [CC80].

1702 [Knox61] chronicles the history of enthusiasm. Other terms often used more or less synonymously with *enthusiasm* are *illuminism,* i.e. the belief that one is directly illumined and led by God and thus infallible and incapable of sin, and *quietism,* the view that, by annihilating one's own psychic life and attaining a state of total inner passivity, one can become so united to God and so detached from one's own carnal trammels that one no longer is capable of sinning, whatever misdeeds one's lower appetites may make one commit, nor needs to care about external worship, prayer, the sacraments, pious exercises, and suchlike (see [Pace11]). [Davi43] makes an interesting distinction between a Platonic-Augustinian "mystical" and a Montanist "enthusiastic" sensibility within Christianity, characterising the former as a "regenerative gradualism", where the mystic, striving to feel God's presence as a "theopath", arduously struggles to ascend to God, by God's grace, through spiritual discipline and exercises via a number of temporally protracted stages (typically five, viz. "awakening", "purification", "illumination", "the dark night of the soul", and "union"), whereas the Enthusiast or "theolept", prompted by a kind of "inspirational automatism" and besotted by a feeling of being seized upon by God, of being a "theodidact", whom God deigns to teach directly, more or less equates the stages of awakening and union, skipping the strenuous and time-consuming mystical pilgrimage altogether and prophetically proclaiming new truths and heterodox re-interpretations of old ones point-blank. Whereas the mystic cherishes "order, peace, and wholeness" and tends to be generally conservative, orthodox – often with a strong penchant for Catholicism or Catholicising forms of piety –, and sceptical of science and democracy, the enthusiast will usually be rabidly radical and utopian, sectarian and freethinking – often embracing an emotional deism or pantheism –, and sceptical of all authorities, be it in the Church or in society at large, and will be prone to demagogy, rabble-rousing, and "enthusiastic" appeals to democracy, equality, fraternity, liberty, and the like. From a Catholic point of view, [Duba97] attempts to develop a theology of discernment, based on the concept of "authenticity", defined as "a not-being-false or merely an appearance". Notably this notion comes close to the Eastern Orthodox conception of *nepsis,* the circumspect soberness held to be indispensable in theological and philosophical matters. Cf. also [Poul1908], [Ward92] section VI, and [Jasp94] p. 117 et seqq.

who bade man eat the fruit of knowledge, rather than the stern and demanding God of the Old Testament.[1703] In fact, brazen and rebellious *inversion,* as exemplified by such inverted hermeneutics, but by no means restricted to it, seems to be the most prominent feature commonly shared by the different groups of Gnostics.[1704] More specifically, they can be characterised by their strongly speculative-theosophical, other-worldly, anticosmic, antisomatic, and dismally pessimistic orientation, which, for example, came to the fore in:

- their gloomy view of the cosmos as the handiwork of a bungling or evil Demiurge, mostly identified with the God of the Old Testament, and as controlled by the spiteful celestial powers referred to as *archons,* amongst whom the Demiurge will be the most prominent
- their promulgation of their own surrealist mythological-apocalyptic and rank emanationist figments and speculations about the *Pleroma, the aeons, the archons,* etc. as absolute, saving knowledge
- their pre-occupation with occult lore and unsavoury magic practices and rites so as to gain power over the forces that rule the cosmos
- their penchant for the relentless and defiant pursuit of liberation from the Demiurge's miserable scrap universe and their own detested bodies through ascetic austerities or anti-nomian debauchery, which, the sooner the better, would, they hoped, wear down the flesh that binds them to material existence and, thus, bring about their own self-salvation and return to the Pleroma.

In scholarly discourse, the term "Gnosticism" is often reserved for the very religious movements of the first centuries of the Christian era discussed here, whereas "Gnosis" is used as a generic term to denote the belief in the salvific power of esoteric knowledge as a more general phenomenon.[1705] Conventionally, ancient Gnosticism is partitioned into a strictly dualistic *Iranian* branch, of which Manichaeism and Mandeism are the foremost examples[1706], and a *Syriac-Egyptian* one, "Gnosticism proper", where the dualism is softened by the idea of a cosmic fall. Of the most well-known Gnostic heresiarchs, Simon Magus, Marcion, Basilides, Valentinus, and Carpocrates belong to the Syriac-Egyptian branch, and Mani will be the foremost representative of the Iranian type. The popularity of ancient Gnosticism seems to have culminated in the second and third centuries and then to have declined slowly, or perhaps rather to have gone increasingly underground.

Although there are many widely different variants of the Gnostic myths and speculations, their plot, if we somewhat arbitrarily confine our discussion to the Syrian-Egyptian systems, is usually based on the emanation of a varying number of *aeons* from the absolutely inscrutable, impersonal Divine Abyss, the *Propator,* the unknown "good" God. These emanations together make up the *Pleroma,* the fullness of the non-material, supersensible realm of light. Through some kind of fall, flaw, mishap, sin, or seduction that happens to one of the aeons, most frequently the feminine *Heavenly Sophia/Wisdom/Barbelo* or the androgynous (or male) *Primordial Man/Adam,* the material world and its evil *archons* come into being. The evil archons, commonly referred to by the Old Testament names for God or, *en masse,* as the *Hebdomad,* were identified with the seven planets,[1707] which in contemporary astrological belief were thought to domineer man's fate, *heimarmene,* in the most adverse manner. One (or, in some cases, all) of these demonical archons, most often the outermost – i.e. the planet Saturn –, frequently referred to as the *Demiurge* or *Ialdabaoth* and equated with the God and law-giver of the Old Testament, was held to have created or ordered the base material cosmos, also known as the

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[1703] The scholarly literature on Gnosticism is unwieldy and has grown at a tremendous pace all since the discovery of the Nag Hammadi codices in 1945 (translated in [Robi90]) – some useful resources are [Rudo94], [Jona54], [Jona66], [Jona93], [Jona91], [Quis74], [Leis85], [Wils58], [Dore86], [Coul92], [FB97], [Trög01], [Wolf76] p. 495 et seqq., and the collections of papers [Bian67], [BV81], and [BH98].

[1704] Cf. [AW01] p. 218 et seqq.

[1705] See [Anon67].

[1706] As noted above, Manichaeism emerged from the Judaizing Christian sect of the Elcesaites. The strange, still extant Iraqi sect of the Mandeans, albeit being hostile to both the Christian and Jewish religions, apparently originated in a Jewish-Christian ambience, as will be clear from its own traditions, from some of its doctrines, and from the rôle St. John the Baptist plays in it as a prophet. See [Rudo94] p. 379 et seqq.

[1707] Besides the five planets proper, these included the Sun and the Moon.

realm of darkness or the *Kenoma,* the emptiness, in which somehow the spirits of men, usually conceived of as the flashes or particles of a fallen light being or aeon, such as the Heavenly Sophia or the Primordial Man, have become trapped. Christ is usually interpreted as a docetic visiting professor from the Pleroma, whose task as the Saviour is not the atonement of man's sins on the cross, on which only a phantasm or another person looking like Jesus (such as Simon from Cyrene or even Judas) was made to suffer by some magic trickery[1708], but to instruct the trapped flashes or light particles about their divine origin and impart to them the necessary instructions of how to repair back to the light world – for instance, by taking advantage of certain magic watchwords that would make the archons allow the heavenly voyagers to pass through the celestial spheres on their ascent towards the Pleroma, where they, at least in some systems, would re-unite with their own heavenly counterparts through the "mysterium coniunctionis". Thus, the return of all light particles to the abstract, immaterial light-world through their own self-salvation and the concomitant annihilation of the Demiurge's material creation together with the undoing of the trap of bodily existence will be the object of the eschatological hope of Gnostic historiosophy – not a transfiguration of man's current form of bodily existence by his assumption of the *corpus gloriosum* or a new creation of Heaven and Earth, shorn of evil, as in orthodox Christian belief.

Some sects held that only a small élite of men, *the pneumatics,* was descended from the light world or at least apt to regain it, whereas the others, *the psychics* (often then used as a synonym for "ordinary" Christians) and *the hylics* (people of a materialist bent), who were of a more humble ancestry or lacking in spiritual competence, could not be saved, at least not in the full sense of the word, as also pre-eminently evidenced by their want of sympathy for the pneumatics' insights. Commonly, the pneumatic élite bestowed on itself the privilege of freedom from all ethical restraints, which were held to be commendable only for the rank and file of the psychics. Notably, some extreme Gnostic sects made it their supreme obligation to break every moral commandment given by the ill-liked Demiurge. As part of this antinomian and anticosmist programme, they are reported to have indulged in the most extravagant libertinism, magical rites, and disgusting practices and behaviours, including ritual murder and cannibalism, to have objected to and tried to prevent the reproduction of mankind, and defiantly honoured all the enemies of God mentioned in the Scriptures, from the Serpent of *Genesis,* Cain, Core, and the inhabitants of Sodom to Judas Iscariot. These sects became so infamous for their depravity and wickedness that they for a time were able to put a stigma on orthodox Christianity as well, possibly bearing the brunt of the blame for the extremely unfavourable judgements about Christians found in some ancient authors, such as Tacitus and Celsus.[1709] Plausibly, their excesses conduced considerably to the formation of the animus that brought about the extraordinary persecutions of the Christians in the otherwise religiously rather tolerant Roman Empire.

Despite extensive scholarly attention to the matter, the origins of Gnosticism are tantalisingly obscure. For one thing, it remains controversial whether it is meaningful to speak of a pre-Christian Gnosis. Influential scholarly theories have attempted to derive Gnosticism from Zoroastrian dualism, Greek (Empedoclean, Pythagorean, Platonic) religious philosophy or (Orphic, mystery-based) philosophical religion, Jewish (or Jewish-Christian) mysticism, philosophy, and angelology, Samaritan religion, or some blend of these.[1710] Although it seems undeniable that the religious and philosophical syncretism of Hellenistic culture influenced Gnosticism fundamentally, its main traits – anticosmism, antinomianism, libertinism, excessive asceticism, élitism, subjectivism, individualism, alienation, nihilism, anthropocentrism, etc. – are more easily construed as the perversion or derailment of certain elements of the Christian gospel, grounded in a relentless radicalisation of the antithesis between the Old and New Testament, the "law of Moses" and the "law of freedom", the Jewish and the Christian religion, where the Old Testament together with its conception of God, its morals, the Jewish people, etc. are endowed with the demonic attributes that were to become an integral part of most later anti-Semitism. Although we cannot attempt this here, it would not be difficult to show how the basic Gnostic ideas and sentiments can be derived from individual passages of the New Testament through an

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[1708] Some Gnostics preferred *separatism* to *docetism,* viewing the divine messenger Christ and the man Jesus as two separate entities, who were united at the baptism and parted ways before the crucifixion, which, thus, was suffered only by Jesus.

[1709] See [Benk80].

[1710] See [Rudo94] for a discussion of these theories.

intemperate, "pneumopathological" exegesis of them.[1711] Certainly, St. John's words about the "antichrists", who "went out from us, but … were not of us"[1712] provides a strangely apt characterisation of the Gnostics. This is also why the orthodox defence against the different forms of Gnosticism has always been a very delicate task, demanding the greatest theological discernment in order neither to let the pneumopathologic devil in, nor to throw the baby of the life of the spirit – without which religion becomes but a sere shell – out together with the muddy waters of the Gnostics', enthusiasts', and free-thinkers' unbridledly subjectivist forays towards a grand "Umwertung aller Werte".

Rationalism, which is commonly construed as the antithesis of Gnosticism and enthusiasm, commits just the latter error by unduly downplaying the supernatural and by gravitating towards thisworldliness and naturalistic and rationalistic simplifications. In the early Church, such rationalism was not a very common phenomenon and only gained prominence much later, mainly in liberal Protestant theology and amongst various Protestant sects, such as *Unitarians* and *Universalists,* although some Church historians have thought themselves able to perceive rationalist tendencies also with some early, but rather obscure Christian factions opposed to the Logos doctrine or reluctant to recognise the full divinity of Christ, such as the *Alogi,* the *Theodotians,* the *Artemonites,* and the *Adoptionists.*

More important divisions held suspect for rationalist tendencies included the two great Antiochene Christological heresies, *Arianism* and *Nestorianism.* The Antiochene School of theology, from which many influential heterodox theologians emerged, including Paul of Samosata, Lucian of Antioch, Arius, Theodore of Mopsuestia, and Nestorius, cultivated a rather bald grammatical-historical exegesis of the Bible savoured by heavy doses of Aristotelian logic and a propensity for Pelagianism in questions of morality, which all may seem like indications of 'rationalism' as good as any. In particular, such ideas were espoused by the greatest of the Nestorian theologians, Theodore of Mopsuestia, who even went so far as to reject the canonicity of Biblical books, in which the allegorical element was salient, such as the *Book of Job, the Canticle of Canticles,* and the *Apocalypse.* The Antiochene predilection for austere grammatical-historical exegesis, as pursued by Diodore of Tarsus, Lucian of Antioch and Theodore, is often explained as the outcome of academic and national rivalry between the Antiochenes and the speculative, allegorising theologians of Alexandria. Also the stark antithesis of Alexandrian Monophysitism with its emphasis on Christ's divinity and unity and the Antiochene tendency to stress Christ's humanity and the separateness of His two natures is often construed in terms of such rivalry, as is the Alexandrian inclination towards 'mystical' Platonism vis-à-vis the Antiochene preference for 'rationalist' Aristotelianism.[1713]

The heretical deformation of the Christian faith and gospel reflects a latent danger inherent in the heightened devotion to God, moral goodness, and purity of heart that is Christianity. Additionally, the Christian reliance on subjective conscience and interior experience rather than on more simplistically objective standards, such as the outer observance of the Mosaic law or the Islamic sharia, as the ultimate criterion of moral integrity and piety, and, by extension, truth, will also invite heterodox deformation. Two points can be made as to this problem.

Firstly, the Christian way of life demands a fair amount of discernment, maturity, sense of balance, and responsibility lest derailments should ensue. Thus, by the derailment of the virtue of devotion, fanaticism and extremism may easily emerge, and, through the derailment of the reliance on conscience, will burgeon

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[1711] See [Wolf76] p. 495 et seqq. for many examples. One startling instance is Marcion's application of *Luke 6.43* (the statement about the tree being known by its fruit) on the creation as a whole, leading him to conclude that as the creation contains so much evil, its Creator, the Demiurge, must himself be of an evil bent (see [Osbo87] p. 102 et seqq.).

[1712] *1 Ep. Jo. 2:19*

[1713] Although some of the doctrines espoused by one or other of these factions – such as the denial of the divinity of Christ, the rejection of the Logos doctrine, disbelief in the Paraclete and Holy Ghost, or a devotion to literal exegesis at the cost of spiritual-allegorical hermeneutics – may appear "rationalistic" to the modern mind, seen in context such interpretations often tend to become moot or untenable. See, for example, [Wile96] on the case of Arians, whose denial of Christ's full divinity and consubstantiality with the Father hardly can be construed as "rationalist" in the modern sense of the word, but more probably was rooted in a Judaizing view of the Messiah as an 'ultraarchangelic', but not genuinely divine being, somewhat along the lines of the "Son of Man" in the *Book of Enoch* and kindred writings. Cf. also [Fowd93a] p. 209. The picture of Theodore of Mopsuestia as a modern-style rationalist hardly tallies with his (and some other Syrian Christians') rejection of the Pythagorean-Platonic notion of a round Earth for the traditional Oriental idea of it as a flat dish with the great world-mountain, around which the heavens revolve, located in the far north (see [West71a] p. 106 et seq.). On Theodore's theological ideas, see [Baur12]. Cf. also footnote 1718 on p. 365.

licentiousness, subjectivism, individualism, free-thought, and kindred vices, as demonstrated, in particular, by the heresies of enthusiasm and Gnosticism.

Secondly, the Christian commitment to conscience, the highest ethical standards, and inner purity inexorably reveals man's fallen nature and sinfulness to himself and, when rightly perceived and assimilated, this exposure will make for humbleness, self-insight, and spiritual maturation. Job, living in the era of the Mosaic Law, could still lay claim to perfect righteousness on behalf of himself, although in the end he had to give up his own pride and self-righteousness to become reconciled to God. The Christian insight into man's own sinfulness and imperfection will, however, be too hard a scandal to bear for many, who may be wont to conceive of themselves in far rosier terms than as abject sinners and recoil at the prospect of becoming guilt-ridden wretches. Thus, amongst some, the fear of sinking into an abyss of guilt and self-humiliation will call up the countermove of their asserting their own innocence and laying the blame on the Creator of the world, or, by escalation, ignoring or abolishing him. Hereby they, however, will become apt to contract the epidemics of egolatry, nihilism, and cosmic paranoia so typical of all the Gnostic 'maîtres du soupçon' from Simon Magus to the neo-Darwinists. Amongst the Gnostics, this assertion of man's blamelessness is escalated into a declaration of man's divinity, and thus the inversion becomes complete: God, the Demiurge, is rendered an evil spirit, and Man becomes the good God, the divine spark abducted from the Pleroma and entrapped in the Demiurge's disgusting cosmos of lowly and vermin-infected materiality.

From a Christian point of view, this inversion is, of course, sheer madness, amounting to the sin of pride, the root of all sins, and, according to the Christian understanding of atonement, an insuperable obstacle to man's reconciliation with God through repentance, confession, absolution based on Christ's vicarious sufferance, and the subsequent labour on personal reform. To the first Christians, heresy, the destruction of the original, "right" Christian faith by personal choice and adaptation, appeared as a very deep form of spiritual sin rooted in just such pride and, to a lesser extent, in the other mortal sins that ultimately flow from it, perhaps even a variety of what the Bible refers to as the impermissible "sin against the Holy Ghost", if this is understood as the fatuous attempt to deceive God by deceiving oneself and trying to force reality into a preferred shape by means of make-believe and conjuration. The mystery of the proliferation of heretical sects and the sectarians' recalcitrance to argument was thus construed as a reflection of the struggles between the heavenly powers of good and evil, of which the latter are always busy trying to instil in men, by all kinds of temptations, the pride and other errors which come to the fore in heresy. As the Church to its grief and alarm found out when wrestling to ward off the deadly attacks of the Muslims and the Cathars, heresy, being rooted in the allurements of sin, can perhaps be vanquished by the sword, but very seldom be overcome by persuasion.

This is particularly true about modernism, the latest and plausibly most virulent and extreme of all gnosticising heresies – for a heresy it surely is, as argued by Hilaire Belloc[1714] and many others –, which, having chosen to cross out God the Demiurge, Christ, the Holy Ghost, Revelation through Scripture, and most moral commandments and spiritual values cherished by Christianity, instead has opted for the anticosmism, nihilism, subjectivism, élitism, individualism, alienation, libertinism, antinomianism, and cult of Knowledge and Man so typical of the ancient Gnostics, retaining all kinds of gruesomely distorted flotsam and jetsam derived from the once prevalent Christian beliefs and perceptions.[1715] So, it forges ahead in a truly Gnostic attempt to regain, by knowledge, self-salvation, and the shibboleths of the modernist magic of science, politics, and technology, the fullness of the *Pleroma,* albeit now immanentised, folded into the present faulty, but, so the saying goes, infinitely perfectible cosmos, which at the end of history shall be transformed into a perfect pleromatic light-world, although this can of course only be achieved by the annihilation of the miserable scrap-world put together by the unfair Demiurge.

[1714] [Bell91] p. 143 et seqq.

[1715] See [Jona91] and [Coul92] p. 249 et seqq.

3.3.4.2 Orthodoxy – The Struggle for Authenticity

> *For we wrestle not against flesh and blood, but against principalities, against powers, against the rulers of the darkness of this world, against spiritual wickedness in high places.*
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> *Ep. Eph. 6:12*

As the challenge of heresy grew increasingly pressing, the Christian Church had to make clear wherein the difference between the "right" or "genuine" Christian faith, *orthodoxy,* and the Gnostic and other heterodox deformations consisted. This was achieved by emphasising the importance of the *Apostolic* tradition, the chain of genuine teachings going back to Christ via the Apostolic succession, set down by the magisterium of the Apostolic Church, by the creeds that summed up the main points of the Christian doctrine, and by the canon of texts generally recognised as genuine, definitely established only in the 4th century, but by and large agreed upon already in the 2nd, to wit the four gospels, the Acts of the Apostles, St. Paul's and a few others' epistles, and the Revelation of St. John. The defence of Christendom and formulation of orthodoxy were undertaken by the Fathers, arguably the leading intellectuals of their own times.[1716] Of particular importance were the writings of the three great Cappadocian theologians St. Basil the Great, St. Gregory of Nyssa, and St. Gregory of Nazianzus, and, in the West, of St. Augustine.

The formulation of Christian creeds, in which the main points of the Christian faith were established as precisely as possible, was largely motivated by the proliferation of Christological errors, due both to the Gnostic attempts to use Christianity for their own syncretistic ends and to a more general difficulty in grasping the mystery of the incarnation, i.e. how Christ could be both man and God at one and the same time. The Gnostics had conceived of Christ as a messenger from the immaterial light world, a divine aeon, wholly untainted by evil matter and, thus, equipped with a phantom body only, whereas others regarded Him as some kind of semi-divine being or robbed Him of His divinity altogether, making him but a wise teacher and thaumaturge. So we are told that St. John was moved to write the fourth gospel, with its identification of Christ with the divine Logos, in order to defend the divinity of Jesus against a certain Judaizing Gnostic named Cerinthus, who had ventured to deny this fundamental Christian belief, as indeed probably most of the Judaizers did. In his first epistle, St. John also fought *docetism,* the teaching of various other Gnostics, such as notably the school of Simon Magus, that Christ only had had an illusory body and thus was not fully human.

But even when these extreme views had been disposed of, there remained problems. Were Christ and the Father identical or were there actually two Christian gods? How did the Holy Ghost, which descended in the form of a dove upon Christ at His baptism and was outpoured amongst his disciples at the first Pentecost, relate to them? If Christ is both man and god, as is the import of the mystery of incarnation, how is this to be understood more precisely? The sequence of ecumenical councils of the Church, of which the ones held in Nicaea in 325, Ephesus in 431, and Chalcedon in 451 stand out as the most important, grappled with these and many kindred problems. Taking advantage of the philosophical language of the time, they established the doctrines of the Trinity and of the two natures of Christ, the divine and human joined together in an intimate 'hypostatic' union, as the most faithful rendition both of the apostolic tradition and of the relevant passages in the gospels and epistles recognised as authentic.[1717] Thereby, they also rendered heretical the views of the fac-

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[1716] Migne's *Patrologiae cursus completus,* of which the Latin series comprehends 222 volumes starting with Tertullian and ending with Innocentius III and the Greek series 168 volumes starting with Clemens Romanus and ending with the Council of Constance, remains the most comprehensive edition of the writings of the Fathers, although more recent collections of their works, such as *Corpus Christianorum, Corpus Scriptorum Ecclesiasticorum Latinorum, Die griechischen christlichen Schriftsteller der ersten Jahrhunderte,* and *Sources chrétiennes,* will sooner or later catch up. The three series of *The Ante-Nicene Fathers* and *The Nicene and Post-Nicene Fathers* provide a selection of the most important works of the fathers in English translation in 38 sturdy volumes – many other such selections exist. On the development of Christian theology in the Early Church, see [Kell78]. A comprehensive introduction to patrology is provided in the four volumes of [Quas95], whereas [Tixe57] and [Hame68] are more concise, but still useful handbook exposés; the philosophical aspects of the Fathers' teachings are handled in [Wolf76], [Osbo81], and the relevant portions of [Arms70].

[1717] The terminological apparatus used to define these concepts was borrowed from the contemporary, often tantalisingly ambiguous philosophical language, which of course must be mastered, if one is to understand these doctrines and the controversies that surrounded them correctly. See [Wolf76]. For some elucidating remarks on the usage of key concepts such as *ousia* (substance), *physis* (nature), *hypostasis* (subsistence), and *prosopon* (person), see [Chap09b]. Cf. also [Coul92] p. 8 et seqq., which, despite its silly "morphodynamical" nihilism, presents an instructive diagram of the different views. The orthodox standpoint asserts that Christ had both a divine and human

tions of the *Arians,* who held that the Father and the Son were not of the same divine substance and that the Son had been created in time, not born before all time by the Father, the *Monophysites,* who, stressing the divinity and unity of Christ, contended that Christ's divine and human natures were united into one theandric *nature* according to the formula ***μ□α φύσις τοῦ θεοῦ λόγου σεσαρκωμ□νη***, the *Nestorians,* who instead emphasised the human aspect of Christ and the separateness of his both natures by their insistence on a clear-cut division between the human and the divine hypostases in Christ, rather loosely united by conjunction (***συνάφεια***), actualisation (***□ν□ργεια***), or (God's) good pleasure (***εὐδοκ□α***)[1718] in Christ's *person.*[1719]

We do not here need to track the further fates of these nascent heterodox national Churches, the abortive attempts to reconcile them through the proposed doctrines of monotheletism and monergetism, and all the dogmatic developments and controversies that followed up to the seventh ecumenical council in Nicaea in 787, the last ecumenical synod recognised by both Eastern Orthodox and Roman Catholic Christianity – as well as by most Protestants.[1720] The fervour of all these dogmatic controversies, which, for all their subtlety, were not ridiculous hair-splitting about unimportant details of the Christian faith, but concerned its very eponymous heart, Christ Himself, really bears splendid witness to the victory of Christianity and the significance now generally accorded to a proper understanding of the revelation of being and the salvific grace that Christ had bestowed upon men.

nature united in one hypostasis or person. Additionally, the human nature is *anhypostatic,* insofar as it lacks a separately existing hypostasis of its own, but has its hypostasis in the divine hypostasis *enhypostatically.*

[1718] Possibly these terms, which were used also by Theodore of Mopsuestia, were meant to convey something like "mystical union", in which sense at least *συνάφεια* had been used by the Fathers for quite some time. Perhaps Nestorius and Theodore, rather widely held to be crypto-Ebionites amongst their theological critics, conceived of Jesus as a man, who had been in a state of "mystical union" with the Logos all His life. See [Wolf76] p. 451 et seqq. and p. 605 et seq. See also [Colp81], [Quis74] vol. I p. 140 et seqq., [Broe98] p. 96 et seqq., and [Jung68] for a discussion of the idea of the *mysterium coniunctionis* of man with his "guardian angel", "twin", "holy spirit", or "higher self" in Greek philosophy, Jewish religion, Judaizing Christianity, Valentinian Gnosticism, Zoroastrianism, Manichaeism, Catharism, and alchemy. Cf. also [Corb98] and [Corb93] p. 51 et seqq. et passim for a discussion of the identification of the *intellectus agens* (on which [Merl63] and [Davi92a] should be consulted) with the spirit, the Holy Spirit, the archangel Gabriel, and the angel of Revelation in Islamic theosophy and mystical philosophy. Although the belief in personal 'guardian angels' is indeed Christian and endorsed by Christ Himself (see *Ev. Matt. 18:10*, cf. also *Ap. Act. 12:15),* the identification of the guardian angel with the 'higher self', or even with God (perhaps as the Holy Spirit), or, pantheistically, with both will hardly be acceptable from an orthodox Christian point of view. In fact, the early Christians were brutally persecuted and killed for their refusal to worship the genius of the Roman emperor – a refusal that would have little point, if the genius were to be identified with the Holy Spirit anyway! Cf. also [Nitz75] and [Davi71a] p. 127 et seq.

[1719] It has been suggested that the aforementioned three factions also embody the emergent national sentiments of peoples disgruntled with the disintegrating Roman Empire, as reflected in the schismatics' nickname 'Melchites' ('imperialists' or 'royalists') for the orthodox. *Arianism,* which initially had enjoyed considerable popularity in the Roman army and been abetted also by some of the emperors of the 4th century before orthodoxy was eventually given the imperial hallmark by Theodosius the Great and was re-affirmed by the Second General Council in Constantinople 381, was favoured mainly by the Goths, who over time were able to take possession of a large portion of the Western half of the Empire. They were, however, gradually brought back to orthodoxy and by the 8th century Arianism hardly existed any more. The stronghold of *Monophysitism* was Egypt, where Alexandria of course was the hub of learning and theology, but it also extended its influence into Syria (through the Jacobites), Arabia, and Abyssinia. *Nestorianism* was predominantly Syrian-Mesopotamian, but periodically enjoyed a favoured status in Persia that made it prosper there as well. Through missionary activities, it was able to extend its sphere of influence over very large parts of Asia all the way to India and China. There was an important Nestorian school in Edessa, which, however, was closed down in 489 by the emperor Zeno, who thereby occasioned the departure of the Nestorian scholars to the Persian Empire, where the Nestorians established academies at Nisibis, Seleucia, and Jundishapur. Whereas the small residues of the Monophysite and Nestorian communities still extant in these areas may seem very insignificant today, they played a crucial rôle in the transmission of Hellenistic-Roman culture and learning to the Persians and the Arabs and also wielded some influence on early Islam. See [Olea49], [Pete68], and [Lind92] p. 163 et seqq. The importance of Jundishapur for the transition of Greek science to the Moslem world strongly emphasised in much older scholarship has been questioned lately – see [Dols87].

[1720] The subsequent ecumenical councils are recognised only by the Roman Catholic Church. Although the relationship between the Roman Catholic and the Eastern Orthodox Churches started to go sour rather early, in particular through the altercation surrounding the patriarchy of Photius around 867, the final schism between them supervened only in 1054.

3.3.4.3 Three Traditionalist Responses – Kabbalah, Neoplatonism, and Hermeticism

> ***Πὰν ὁ μ□γας τ□θνηκε.***
>
> *Plutarch*[1721]

In the gospels we learn that Christ from the very beginning of his ministry met with incredulity and antagonism amongst the leading circles of His own people and, in particular, amongst "the scribes and Pharisees" devoted to the religious traditions of the Jews and amongst the aristocratic party of the Sadducees, who, unlike the Pharisees, rejected the belief in angels, the Messiah, the Resurrection of the dead, and "the world to come" and instead espoused a somewhat unlikely mixture of conservative Jewish legalism, deism, and Hellenistic rationalism. Thus, quite naturally, traditionalist Jews were the first critics of Christianity to work out some kind of response to the new religion, but as Judaism, due to the political-military disasters of the Jewish people, the Jews' linguistic and ethnic isolation, and the rapid universalisation of Christianity, which largely cut its moorings to its Jewish ancestry already in the Apostolic era, lost much of its interest to an increasingly Christian ambience, this exclusivist rabbinical-Talmudic traditionalism may seem to have had only limited influence outside Jewish circles, although the Judaizing Christian sects can be said to represent an attempt at a compromise between Jewish traditionalism and Christianity proper. Additionally, a kind of rationalist-modernist neo-Sadduceeism, apparently owing at least some of its spiritual heritage to the ancient Sadducees, has, starting with Spinoza, wielded a strong influence on Jewish intellectuals and, through them and their often vociferous anti-Christian polemics, on the entire modern world.[1722]

One particular element of the traditionalist Jewish response to Christianity, an element that can only be referred to as "traditionalist" with some qualification, as it was in essence revolutionary rather than traditionalist and implied a boldly immanentist interpretation of the Jewish Messianic-prophetic legacy foreign to many Jews of a conservative bent or with some sense for the political realities of the time, would not only make a fateful impact on the Jewish people during the century that followed upon the crucifixion of Christ, but was to have far-reaching implications for posterity, extending far outside the Jewish nation proper.[1723] Spurred by their own refusal to accept the crucified Jesus of Nazareth as the Messiah, who by his disciples was even scandalously held to be God Himself "come in the flesh", that is to say by their rejection of the Christian paradox of God's incarnation and descent into this world for the purpose of man's promotion into the otherworldly, Messianic "Kingdom of God", these men committed themselves to a revolutionary-nationalist Messianism as starkly opposed to the Christian supernaturalist variety as possible, setting their hope on a human warlord Messiah and expecting the establishment of a Jewish-Messianic utopian kingdom altogether of this world rather than of a Christian "world to come". Thus, by rejecting the transcendentalist Christian form of apocalypticism, according to which the Messianic-apocalyptic events will be driven by spiritual forces from *outside* this world, be of an altogether spectacular order, and, most spectacularly of all, end up in the Resurrection of the Dead, the Judgement of the world by the crucified Messiah, "the Son of Man"[1724], and the creation of a new Cosmos, where the saved will be gathered in the Heavenly Jerusalem, and by instead favouring their own innerworldly, political-nationalist Messianism, the dream of the purified Jewish state liberated from the oppressive yoke of Roman supremacy, the perfect terrestrial Jerusalem, as it were, they would not

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[1721] *De oraculorum defectu 419C.* According to a later Christian legend, the point of time, when the cry "The great Pan is dead" was heard from the island of Paxoi by the travellers on board a ship passing by as recounted by Plutarch, was the very hour, at which Christ died on the cross.

[1722] The revival of Sadduceeism was noted already by Joseph Glanville in the 17th century, as he wrote his *Saducismus Triumphatus,* arguing that neo-Sadduceeism was to be conquered by the empirical evidence for supernormal phenomena.

[1723] On Jewish apocalypticism, see [McGi94b] p. 3 et seqq. and the essays in [MCS98] vol. I p. 127 et seqq.

[1724] [Coll98b] p. 149 suggests that some portions on the "Son of Man" who figures in the *Similitudes* of *1 Enoch* (37-71) were composed during the first century A.D in Jewish circles opposed to Christ's claims to this title. One may ask if this may not be true for the *Similitudes* in their entirety, although current scholarly opinion rather seems to be inclined to attribute this piece of apocalyptic-Messianic writing either to an early (Jewish-)Christian origin or to some pre-Christian Jewish sect or faction. One may also ask if the portrayal of the "Son of Man" as a kind of archangelic figure in the *Similitudes,* fought in the *Epistle to the Hebrews,* might not have provided at least part of the inspiration for the heresy of Arianism and whether this was not an important reason for the growing unpopularity of the *Book of Enoch* amongst Christians in late Antiquity.

only bring upon the Jewish people terrible catastrophes, lending undeserved respectability to ill-advised and inauspicious military adventures of various self-styled Messianic pretenders, such as Bar Kochba, but also give the impetus to an immanentist, revolutionary brand of Messianic apocalypticism and utopianism, which would provide the heartbeat of early Islam and also from time to other infect Christianity itself, or at least some enthusiast divisions of Christianity, in particular after this kind of agenda had been re-introduced into the Latin West from the East by Joachim of Fiore and his millenarian followers during the High Middle Ages.

Also of great significance for the future – and perhaps more so than the harsh anti-Christian polemics of conservative Jews – were to be the different forms of Jewish mysticism that later came to be subsumed under the term *Kabbalah* (tradition). Tacitly assimilating much of the Christian thrust towards a deepened life of the spirit and rejection of the superficial aspects of Judaism, these currents now took a turn towards further spiritual interiorisation and the intensification of the mystical quest for God.[1725] The Kabbalah has often been characterised as a kind of Jewish Gnosis, but although it shared in some of the features of Gnosticism (and Neoplatonism), such as emanationism, the practice of soul-travel, alphabetic mysticism[1726], and an interest in occult lore and magic, the Jewish mystics and Kabbalists mostly shunned the inverted ethics and anticosmism of the Gnostic sects, and, on the whole, Gnosticism will owe more to Jewish mysticism than do Jewish mysticism and the Kabbalah to Gnosticism. We cannot here go into the complexities of the various Kabbalistic doctrines and practices, of which some of the more significant elements are the fourfold *PaRDeS* method for the exegesis of the Bible[1727], various letter and number manipulations used to extricate hidden meanings from the Biblical text[1728], the highly developed lore about the divine *Tree of Life* with its ten *sephiroth* – "numbers", emanations, properties, or aspects of God, supposedly representing the creative energy radiating from the ineffable divine unity, *Ain Soph,* "the Infinite", down to the created world, but also providing a road map for the soul's meditative journey back to God –, a trichotomist doctrine of the parts of the human soul[1729], in which beliefs in metempsychosis and pantheism occasionally played a part, and the doctrine of the four worlds *Atziluth* (the World of Emanation, the realm of the archetypal), *Briah* (the World of Creation, the realm of the archangelic and the throne of God), *Yetzirah* (the World of Formation, the realm of the angelic and "imaginal"), and *Assiah* (the World of Action, the physical universe).[1730] In spite of the severe punishment for sorcery stipulated in the Mosaic Law, another aspect of the Kabbalah that gained widespread popularity early on was magic in different forms, on which a sizeable pseudonymous literature – Moses and Solomon will be the most common author names attached to these so-called *grimoires* or sorcery books – circulated in the Middle Ages and later.[1731] It is in this context the theurgical practices connected with the *Golem,* to which we

[1725] The father of much of the modern scholarly interest in the Kabbalah was the late Gershom Scholem, amongst whose most important works are [Scho74a-b], [Scho87], [Scho91], and [Scho96]. The scholarly literature on the Kabbalah is very comprehensive and tends to become increasingly specialised. Leading researchers in the field include Moshe Idel, Peter Schäfer, and Elliot Wolfson, just to name a few of the most influential scholars. Older studies of interest include [Good35] and [Boks81].

[1726] See [Dorn25] p. 133 et seqq. et passim. Amongst the Gnostics, Marc of Memphis was much concerned with alphabetic speculations. See [Scho91] p. 25 et seqq.

[1727] The four hermeneutic planes of this method by and large parallel the Christian literal, tropologic (moral), allegoric (typological), and anagogic (mystical) meanings. On these, see [Luba59].

[1728] The most important of these methods are *gematria,* the search for hidden meaning through the calculation of the numeric values of words and phrases (exemplified by the apocalyptic number of the beast "666", which is supposed to be the gematric number value of the name of some enemy of Christianity), *temurah,* "transposition" a kind of anagrammatic cipher, by which words can be transposed into other words so as to reveal hidden correspondences, and *notariqon,* an acrostic technique used, for example, in the early Christian fish symbol, which was a kind of shorthand for the phrase Ἰησοῦς Χριστὸς Θεοῦ Ὑιὸς Σωτήρ,(Jesus Christ God's Son Saviour), the initials of each vocable together making up the Greek word □χθύς, fish.

[1729] The three parts of the soul are *neshamah,* the higher self or spiritual core of the soul supposed to be immortal and perhaps even (partly) divine, *ruach,* spirit, which encompasses the higher faculties of the soul, such as memory, will, imagination, and reason, and *nefesh,* the soul proper, perhaps best understood as a vital substrate or vehicle of the higher spiritual portion of man.

[1730] Above these four worlds, some branches of the Kabbalah, such as, most notably, Lurianic Kabbalah, added *Adam Kadmon,* the primordial man, who, after the divine *tzimtzum,* contraction, which, according to Luria and his followers, initiated the creation, is injected into the resulting empty space as a beam of divine light and a container of the sephiroth and, indeed, of the entire creation.

[1731] See [Blau87], [Trac39], [Schä90], [Dan71], and [Cave78] p. 76 et seqq. Cf. also [Rude88] and [BC38] vol. I p. 226 et seqq.

will come back later, also belong.[1732] Also alchemy was practised by some Jewish mystics and has even been claimed to be Jewish in origin.[1733]

According to the Kabbalist tradition itself, its esoteric teachings go back at least to Moses and his dealings with God on the Mount of Sinai, but, although it seems both possible and probable that there has been a tradition of Jewish mysticism – at least in some sense of that word –, which extends back to the oldest times and the traces of which may be discerned in many Biblical books, the extra-Biblical literary remains of this mysticism are mostly of a rather late date. They start with the visionary Old Testament apocrypha and pseudepigrapha, which in most cases are believed to date from the period 200 B.C. to 200 A.D. and were amongst the writings eagerly studied by the intensely religious – probably Essene – community located at Qumran on the Northwest shore of the Death Sea from the second century B.C. to 68 A.D.[1734] In late Antiquity and the early Middle Ages, the Jewish mysticism referred to by the three watchwords*, Hekhaloth, Merkabah,* and *Bereshit* flourished. *Bereshit* are the first words of *Genesis,* usually rendered "In the beginning…", and, accordingly, the *Bereshit* mysticism was primarily concerned with the mysteries of the creation and the early history of man and the cosmos. In contrast, the focus of *Hekhaloth* and *Merkabah* mysticism was the mystical journey of the soul through the *Hekhaloth,* the seven heavenly palaces, to the *Merkabah,* the throne of God.[1735] Whereas *Sefer Yetzirah (The Book of Formation),* the oldest of the more important works of the Kabbalah, was probably authored sometime between the 2nd and 7th century A.D, the development of the Kabbalah reached its zenith only during the High Middle Ages, in particular in Provence, where the *Sefer ha-Bahir (The Book of Brightness)* was edited in the 12th century and the influential school of Isaac the Blind was established at about 1200, and a little later in Spain, where, in the late 13th century Moses de León is held to have composed the famous *Sefer ha-Zohar (The Book of Splendour),* despite its obliqueness the most famous Kabbalist work[1736], and Abraham Abulafia developed a kind of ecstatic mysticism based on the meditation on different permutations of the Hebrew letters of the names of God. Kabbalism remained vigorous throughout the Renaissance and the early modern era, when, in the middle of the sixteenth century, Isaac Luria of Safed in Palestine reshaped much of its theory along more clearly Gnostic lines, suggesting that an imbalance between the sephiroth ("the breaking of the vessels") had caused the divine creation to go awry, leading to the creation of matter and the *qlippoth* or demonic husks of evil, which trap the sparks of light in matter, and that men needed to take part in the restoration or re-integration *(tikkun)* of the creation to unity with God through

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[1732] See below p. 480.

[1733] See [Pata94] and [Sule71]. In fact, the theory of the Jewish origin of alchemy goes all the way back to Zosimus of Panopolis, and one of the earliest known practitioners of the art, highly revered by Zosimus, was Maria the Jewess (see id. op. p. 9 et seqq.). On Jewish astrology, see [Altm71].

[1734] [Char83] provides authoritative translations of the most important pseudepigraphic writings, whereas [Verm97] does the same for the Dead Sea Scrolls, i.e. the fragmentary writings found in various caves at Qumran at the brink of the Dead Sea and mostly believed to have been hidden there by the Essenes, a Jewish sect much praised by Philo and Josephus (see [Medi58]), although there are also scholars who question the theory of their Essene origin (see [Vand94] p. 71 et seqq. and [BR99a]). Besides this largely visionary-apocalyptic Jewish mysticism, there was the Platonic-Jewish mysticism of Philo, who played an important rôle in the transformation of Platonism into Neoplatonism and, as a supposed convert to Christianity, was highly regarded also by many of the Christian Fathers. Philo also described and admired the *Therapeutae,* a mystic-ascetic monastic society in Egypt reminiscent of the Essenes. Whereas most scholars take the Essenes (and the *Therapeutae)* to be Jewish sectarians (see, for instance, [Vand94]), [Couv96] and, in a more speculative and tendentious vein, [Eise97] have tried to make out a case for the idea that they were early Christian Jews, or, perhaps rather, a Jewish-Christian faction of Christianity, from which the Jewish-Christian sects sticking to the observance of the Mosaic law, the Ebionites and the Nazarenes, later emerged. Possibly, when Philo and Josephus mention the "Essenes", they also included in this group the Palestinian Christians, of whom they both are oddly reticent. To later Christians, the status of these "Essenes", to whom neither the Bible, nor any other extant early Christian writings ever refer by name and whom they probably primarily knew through the writings of Philo and Josephus, seems to have been puzzling: Whereas, for example, Hippolytus regarded them as a Jewish sect, St. Epiphanius mentions Samaritan "Essenes" (**'Εσσα□οι** or **'Εσσηνο□**), Jewish "Ossenes" (**'Οσσα□οι** or **'Οσσηνο□**), and Christian "Iessenes" (**'Ιεσσα□οι)** and also makes a distinction between Jewish "Nasareans" (**Νασαρα□οι** or **Νασαρηνο□**) and Christian "Nazoreans" (**Ναζωρα□οι)**, while also asserting that the Christians were first called Nazoreans **(Ναζωρα□οι)** and then for a short time Iessenes **('Ιεσσα□οι)** before they started to be called Christians (**Χριστιανο□**). That these Essene-Nazarene groups were either closely related or identical to the Jewish-Christian groups referred to as Ebionites and Nazarenes and soon to become increasingly implicated in Judaizing heresies (on these groups, see [Scho49] [Dani58], and [Quis68]), seems likely from St. Epiphanius' account. See [BR99a] p. 151 et seqq. for a discerning discussion of the theological implications of the Qumran findings and the relationship between early Christianity and the Essenes they suggest. On the relationship between Jewish mysticism and esotericism and early Christianity, see also [Stro96b].

[1735] On soul travel and visionary experiences in ancient Judaism, see [Rowl82], [CF95], [Himm93], [Himm83], [Wolf94b], [Culi83], and [Sega80].

[1736] Moses de León himself, however, claimed that the work had been authored by Simeon ben Yochai in the second century A.D.

meditation and certain ritual practices *(kavanah).* However, the Kabbalah lost somewhat in prestige and popularity in the latter part of the 17th century through the scandalous derailment of the Messianic-Kabbalistic movement of Sabbatianism, the leader and Messianic pretender of which was forced to convert to Islam by the Turkish Sultan, and the subsequent rise of rationalistic-secularist currents amongst the Jews, although lately there has been a certain revival of Kabbalism in some Jewish circles, largely in the wake of the intense scholarly attention presently devoted to it.

In the 13th century, the Kabbalah would begin to wield a growing influence on Christian Europe that would culminate during a long period that starts with the Renaissance, when also a Christian Cabala took form,[1737] and ends with the Romantics, after whom Kabbalism has been cultivated mainly in occultist quarters, such as by the Hermetic Order of the Golden Dawn and the various fringe groups that emerged from the afterclap of its demise. Amongst the thinkers, on whom the Kabbalah made a more or less decisive impact, are Raymond Lull, Pico della Mirandola, pope Sixtus IV, who translated seventy Kabbalistic books into Latin, Johann Reuchlin, Cornelius Agrippa, Guillaume Postel, Johann Pistorius, Jacob Behmen, the Cambridge Platonists, Milton Knorr von Rosenroth, who edited the famous *Kabbala Denudata,* possibly Spinoza, the van Helmonts, Leibniz, possibly Swedenborg, Hegel, Schelling, and Sigmund Freud.[1738] More generally, the Cabala is the pivot of the entire Western esoteric-theosophical and occult tradition, including the Rosicrucian and alchemical strains so significant for the emergence of modern science. Already Reuchlin's pupil and Postel's friend Widmanstadt called this impact "a Trojan horse introduced into the Church"[1739] and in the aftermath of the encounter of Christianity with the largely Gnostic, or at least highly unorthodox, Kabbalah, we can observe the proliferation of phenomena strikingly reminiscent of those of ancient Gnosticism, such as unrestrained free-thought, pantheism, atheism, materialism, nihilism, libertinism, antinomianism, and other similar pneumopathological derailments. Perhaps this was, at least in some cases, a natural consequence of the spiritual immaturity and shallowness of the disoriented intellectuals and "seekers", who so eagerly and uncritically embraced the Kabbalah in their own chase for a short-cut to truth, some cheap thrills, and a posy of fascinating new-fangled ideas to whiff, much like their modern compeers turn to neo-Darwinist and similar forms of pop 'science', New Age religion, or drugs to get quick answers to all the mysteries of existence. Notably, the dangers implicit in the study of the Kabbalah had always been recognised by its serious adepts, who surrounded it with many warnings and prohibitions.[1740]

As around 200 A.D. it became increasingly clear that Christianity was a force to reckon with also outside Judaism, nay that it was likely soon to outflank traditional pagan religion and philosophy, the bankruptcy of which was now rather widely felt, some scholars, philosophers, and religionists committed to the old ways took upon themselves the task of trying to forge a conservative pagan reply to the Christian challenge.[1741] This riposte, albeit based on a synthesis of the predominant ancient philosophies, Platonism, Aristotelianism, Stoicism, and Pythagoreanism has become known as *Neoplatonism.*[1742] Momentously, Iamblichus and some other

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[1737] See [Blau44], [Benz58], [Benz83a], [Secr85], [Secr92], [WS87], [Bouw57], [Kunt81], [Swie86], [Dan97], [Schu02], [Rude88], [Rude95] p. 118 et seqq. et passim, and [West55] p. 151 et seqq. Many authors prefer the spelling "Cabala" for the Christian variety, "Kabbalah", "Kabbala", "Kabalah", or "Kabala" for the original Jewish form, whereas amongst occultists the spelling "Qabbala" or "Qabala" is often favoured.

[1738] Besides the works mentioned in the preceding note, see also [Coud95], [Coud99] and [Baka90]. Notably, there are many interesting connections between the Kabbalah and present-day computing. See the section *The Occult and Mystical Roots of Computing* starting on p. 477 below.

[1739] Quoted from [Webb90] p. 221.

[1740] For example, there were injunctions against public lecturing on the Kabbalah and against the admittance to its study of individuals that did not satisfy certain qualifications, such as being a married man of at least 40 years of age. The interesting cautionary tale recounted and expounded in [Idel91] sums up the dangers of the pursuit of the Kabbalah through four paradigmatic rabbis devoted to the pursuit of the Kabbalah: Of these four rabbis, who entered the Kabbalistic orchard or paradise, *Pardes,* one peeked and was smitten (became mad), one peeked and cut down the shoots (became a heretic), one peeked and died (which was not necessarily considered bad), and only one peeked and descended safely.

[1741] Also at about this time, Philostratus even made bold to create a kind of pagan pastiche of Christ by his fabulous account of the philosopher-thaumaturge Apollonius of Tyana [Phil12]. Cf. [Gira01] p. 49 et seqq.

[1742] On how the crucial parts of this synthesis developed, see [Merl63]. This period of the philosophy of history is well covered in [Arms70]. On Plotin, see [Rist77], [Omea93], and [Gers94], on Neoplatonism in general [Wall72] and [Lloy90]. Additionally, the series *Studies in Neoplatonism* issued by the *International Society for Neoplatonic Studies* is of great value to anyone interested in the Neoplatonic tradition.

Neoplatonists, quite in the spirit of Plato himself, attempted to integrate mystical Pythagoreanism into this rehash of all kinds of pagan wisdom, revitalising the philosophical interest in mathematics and number mysticism in ways that would bear unexpected fruit in a distant future.[1743] The first of the pagan critics of Christianity will have been the Platonist polemicist Celsus, whose not very well-informed attack on the new religion was countered at great length by Origen, the most erudite of all the Christian apologists of the third century.[1744] Origen was himself a Platonist as well as a Christian and the pupil of Ammonius Sakkas[1745], a lay philosopher and probably also a Christian by birth – although he might later have apostatised –, who also was the teacher of Plotinus, the man destined to work out the Neoplatonist synthesis.

This synthesis, which in important respects had been prefigured already by some of the "Middle Platonists", such as Albinus, Numenius, and Philo, and perhaps even by Plato himself in his "unwritten doctrine"[1746], was based on an emanationist scheme of three ontological levels or *hypostases,* apparently moulded on the Christian Trinity with its three hypostases.[1747] In this trinitarian scheme, perhaps an attempt to synthesise Platonism and Aristotelianism, the root of being is the unknowable *To Hen* (**τὸ ἕν**)*, the One, God,* from which emanates *Nous* (**νοῦς**)*, the (World) Intellect,* which in it accommodates the Platonic world of ideas or *mundus intelligibilis,* i.e. the divine archetypes or forms of everything that exists. So far, this scheme comes quite close to the Christian understanding of the relationship between the Father and the Son, the *Logos* or the *Word,* if we construe the term *Logos* as roughly equivalent to the *Nous,* conceived of together with the ideas contained in it. However, the next step in the Neoplatonist scheme, which is the emanation of *Psyche* (*ψυχή*), *the (World) Soul,* from *Nous,* sets Neoplatonism apart from orthodox Christianity, insofar as the task of the *World Soul* is to project the ideas/forms resident in the *World Intellect* onto the pre-existing, eternal, formless matter *(materia prima)*[1748]*,* whereas in the Christian view, which is based on the *Genesis* account of the origin of Cosmos, the physical cosmos was *created ex nihilo* at the beginning of time – together with matter and time – from the archetypes in the uncreated, divine *Logos.*[1749]

1743 See [Omea89].

1744 See [Benk80] p. 1101 et seqq.

1745 See [Dörr55] and [Seeb42]. The latter attempts to connect Ammonius with India, suggesting that "Sakkas" should be construed not as "sack-carrier" or "docker", as usually is the case, but as a designation for a Buddhist (monk). On the connections between late Alexandrian philosophy and India, see also [Anwa27], [Benz51], [Harr82], and [Moff98]. There was during some periods considerable trade between India and the Roman Empire via Egypt, and Indian merchants and ascetics occasionally visited Alexandria.

1746 In recent scholarship, Plato's actual philosophical standpoint has been much debated and is now rather widely held to have been quite close to the Neoplatonic scheme, although the exact nature of many of his views remains obscure, as he probably restricted his "unwritten doctrines" to his esoteric, oral teaching and only alludes to them covertly and vaguely in his exoteric dialogues. See [Kräm59], [Kräm90], [Merl63], [Gais68], [Wipp72], [Voge86], and [Szle99]. Various criticisms of the esoteric "Tübingen" interpretation of Plato of course exist, such as [Tige77], which, for all its learning and the scoring of some good points, in the end fails to carry conviction due to the author's modernistic-rationalistic lack of sensitivity to the fundamental spiritual qualities of the pre-modern world.

1747 *Hypostasis* is a somewhat difficult philosophical-theological term, which originally was used by the Stoics as a synonym of the Platonic-Aristotelian term *ousia,* substance, both of the primary and the secondary variety (see [Kell78] p. 129). Later, it became more or less synonymous to "primary substance" and, being rendered *subsistentia* in Latin, was defined as an individually self-existing, self-subsisting thing *(prote ousia, substantia prima, individuum,* or *suppositum),* an instance of an essence or "secondary substance" *(deutera ousia, substantia secunda).* In Plotin, this fine-tuning of the usage has not yet happened and the term is rather to be construed as primary being *(ousia),* inso-far as it is realised and becomes apparent in the individual things (so [Lübc87] p. 245). To Plotin, only *the One, the Intellect,* and *the Soul* are hypostases in this acceptation, whereas formless matter is a non-being, an evil. The usage of the term *hypostasis* for the persons of the Trinity seems to have been introduced by Origen, who was an older contemporary of Plotin. Although the process of an exact dogmatic *formulation* of the Christian Trinitarian doctrine did not come to a closure until rather late, its essential content was part of the original faith of the Church, as epitomised, for instance, in the baptismal formula given in *Ev. Matt 28:19* and as reflected in various passages of the gospels and the epistles (see [Kell78] p. 101 et seqq.). When in Christian Trinitarian theology the word "hypostasis" is used for the three "persons" of the Holy Trinity, the Father, the Son, and the Holy Ghost, it cannot simply be rendered as "instance" or "self-existent thing", which would lead into the theological error of tritheism, but rather, in the words of St. Thomas, as "res subsistens in natura divina", a thing subsistent in the divine nature. In theological language, the relation between the hypostases and the divine essence as well as between the different hypostases is described by the terms "circumincession", "co-inherence", "perichoresis" or "emperichoresis", which all denote a kind of close interpenetration. Nonetheless, each of the three divine hypostases is really *(realiter)* distinct from the other divine hypostases, but only rationally *(rationaliter)* distinct from the divine essence (see [Mull85] p. 223 et seqq. and p. 306 et seqq.).

1748 In Renaissance Platonism, this was supposed to happen via a kind of intermediate, plastic medium, the *World Spirit* or *Spiritus Mundi.*

1749 Albeit differing by its abstract, impersonal choice of terms, the Neoplatonic emanationist scheme does not, at least *prima facie,* seem to be at such a far remove from the Christian Trinitarian doctrine. In the Holy Trinity, the hypostasis (or person) of the *Son* (i.e. the *Logos* or *Christ),* who, similarly to the Platonic *Intellect,* holds the master plan of the world, emanates (or, more precisely, is born) from the

To the Neoplatonist division of the world into the ontological levels of *the One, the World Intellect, the World Soul,* and *Matter,* corresponds an anthropology, according to which man is made up of *Intellect, Soul, and Body*[1750] and somehow participates with his own Intellect in the World Intellect and with his own Soul in the World Soul. Thus, Christian theologians have often branded Neoplatonic emanationism as "pantheism", as it implies that all beings are connected and ultimately derive from *the One* by means of emanation, whereas in the Jewish-Christian understanding of the world men and their souls are separate from God by virtue of being created.[1751] Associated with the Neoplatonic emanationism is a form of unitive mysticism, somewhat reminiscent of the mysticism of Advaita Vedanta, by which the mystic through contemplation ascends via his own intellect to the *World Intellect,* and from the *World Intellect* to the *One,* with which he may then at rare moments experience the ecstatic *unio mystica*, as Plotinus himself did. Voegelin uses the term *noetic theophany*[1752] to characterise this Platonic-Hellenic self-revelation of God through the intellect, distinguishing it from the Jewish-Christian *pneumatic theophany,* where the Holy Ghost, the Spirit of God, instead overcomes the believer by a kind of spiritual or prophetic rapture. To what extent the noetic and pneumatic theophanies overlap, are compatible with each other, or can be ascribed to a common origin, remains an extremely contentious issue amongst religious scholars and theologians.[1753]

Whereas Plotinus did not criticise Christianity explicitly, although he was very ill affected to Gnosticism[1754], some Neoplatonists, such as Porphyry, the editor of Plotinus' literary estate and a prolific and skilled scholar, the emperor Julian, infamously known as the "apostate" due to the attempt made during his reign 361-363 to restore paganism, and Proclus, the perhaps greatest systematiser of the school, came to see themselves as the defenders of the pagan legacy of philosophy, religion, and culture and, thus, ventured to attack

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hypostasis of the *Father,* which, perhaps, can be made out to correspond to *The One,* whereas the third hypostasis, the *Holy Ghost,* which emanates (proceeds or is spirated) from the *Father* through the *Son* (according to Eastern Orthodoxy) or from both the *Father* and the *Son* (so most varieties of Western Christianity, including Roman Catholicism and Lutheranism; see [Cong97] vol. III), seems more difficult to reconcile with the Platonic emanationist scheme. In fact, the equation of the *World Soul* with the *Holy Ghost,* albeit repeatedly attempted by Christian Platonists, is fraught with difficulties. For one thing, the notion of the *World Soul* does not seem to sort well with the prophetic-charismatic dimension of the Holy Ghost, whose major concern in Jewish-Christian religion is, in any case, not with the projection of ideas onto primary matter and in particular not onto a primary matter conceived of as eternal and self-existent. See [Cong97] and [Kell78].

1750 Proclus, being of a systematic bent, perfected this scheme by adding to the set-up of man a *henad,* which corresponds to *To Hen, the One.*

1751 Although God during the act of the creation of man "breathed into his nostrils the breath of life" *(Gen 2:7),* man's soul or spirit is not in orthodox Christianity held to participate in or be part of the divine Logos or divine Spirit, although some heterodox Christian mystics, such as Meister Eckhart, appear to have entertained such ideas. Nor is the sensory world, the *mundus sensibilis,* in the Christian view the result of emanation, but the projection of the "divine ideas" inherent in the *Logos* or *Christ* is instead held to have happened through an act of *creatio ex nihilo* instituted by the *consilium Dei* as *willed* by God's *decretum aeternum.* Even though the Neoplatonic doctrine of emanation, thus, does not seem to sort well with the Christian personalist notion of willed creation, the difference should not be overstated.

Notably, in traditional Christian theology the creation is often divided into three stages, which suggest the possibility of a partial reconciliation with the Platonist scheme, to wit: 1) the *creatio prima* of primary, unformed matter (i.e. spatiotemporality, as accounted for in *Gen. 1:1-2),* 2) the *creatio secunda,* through which form and life are impressed onto primary matter, and 3) the *creatio continuata,* being part of God's *providentia,* through which the contingent beings and the general order of things are conserved, supported, and governed by God's acts of *conservatio* (conservation of the existence of the created order), *concursus* (concurrence in or support for secondary causes, including the operations and actions of the contingent beings, whether good or bad), and *gubernatio* (providential governance of the creation). God is omnipresent in His creation and sustains it through His own *immediatio suppositi* (immediacy of His subsistence or being, by which He supports the being of all things) and *immediatio virtutis* (immediacy of His effective power, by which He supports the secondary causes operative in the creation). The notion of the Church as the mystical body of Christ, the *Corpus Christi mysticum,* also bears witness to the presence within orthodox Christianity of a notion of intimate interconnection of (Christian) men in God. See the referenced terms in [Mull85]. Cf. also [Walk72] p. 120 et seqq. and p. 258 et seqq. and [Dobb88]. On the *Corpus mysticum,* see [Luba49], [Mers54], and [Kell78] p. 401 et seqq.

1752 Similarly, [Merl63] p. 2 uses the term "rationalistic mysticism" to characterise the Neoplatonic brand of mysticism.

1753 While not denying the importance of the Platonic legacy in Christian mysticism, [Lout99] emphasises how the Christian notion of God as a person, revealed through Christ, sets Christian mysticism apart from the Neoplatonic mysticism with its conception of God as an abstract principle, *the One, the Good, the Beautiful.* The intimate dialogue with God, addressed as a "Thou", found, for instance, in the works of St. Augustine and other Christian mystics, is foreign to pagan Platonism. Likewise, [Nygr47] (see also the abbreviated and slightly updated edition [Nygr66]) famously contrasted Christian and Platonic love, the theocentric *agape* and the egocentric *eros.* The contrast often noted between the Christian notion of *salvation* by divine grace, which instils in the believer the *self-oblivion* and love of God and others that show in good works, and the Platonic-Gnostic ideal of *liberation* through one's own actions, aiming at *self-realisation,* also seems to reflect this fundamental difference between the agapistic and erotetic modi essendi. See also [DArc46], [Iván64], [Voge85], and [Corb93] p. 51 et seqq.

1754 See *Enn. 2.9.* Cf. also [Arms70] p. 205 et seqq. and [Puec57].

Christianity in their writings.[1755] The later Neoplatonists, starting with Iamblichus were much given to mythological system-building and, probably due to the influence of the Gnostic *Hermetica*[1756], the intercourse with the gods through *theurgy,* a kind of magic séances reminiscent of present-day spiritistic activities, at which the participants tried to get into contact with the pagan gods and demons through either an idol or a human medium supposedly possessed by the god.[1757] Of the Platonic institutions, the Academy in Athens was particularly committed to paganism, which occasioned its cessation in 529 by the ukase of the emperor Justinian, whereas Platonism continued to thrive in Alexandria – where it had been closely wedded to Christianity since early times – until the capture of the city by the Arabs in 642. Some of the most important of the earlier Christian Fathers, including Clement, Origen, the Great Cappadocians, and St. Augustine, were all heavily influenced by Platonism[1758], although later there was a turn towards Aristotelianism amongst Christian intellectuals, being consequent upon the belligerent polemics and Gnosticising tendencies of the pagan Neoplatonists, but also upon the various difficulties encountered in the attempts to harmonise the Neoplatonic ideas with Christian orthodoxy. This tendency was particularly marked in the Antiochene School of theology and amongst the Syrian Nestorians, but also largely obtains for mainstream orthodox Byzantine Christianity, whereas Platonism remained strong amongst the Monophysites, Eastern Orthodox mystics, and also, in a moderate form, within Latin Christianity through the intermediation of St. Augustine, a few minor works by Neoplatonists translated into Latin, and Plato's dialogue *Timaeus,* which, being the only work by Plato available in Latin during the larger part of the Middle Ages, exerted an immense influence on the medieval mind. The mystical writings of pseudo-Dionysius, probably a Syrian Monophysite Christian and disciple of Proclus, also came to wield a lasting influence both in the Byzantine empire and, after it had been translated into Latin by John Scotus Eriugena in the 9th century, over the Latin West as well.[1759] Whereas the Aristotelian influence would eclipse the Platonic strain of thought during the high Middle Ages, there always remained a strong Platonic undercurrent, which once again became prominent during the Renaissance, as the Platonic corpus as well as the writings of Plotinus were at last translated into Latin by Marsilius Ficino.

At about the same time as the Neoplatonic synthesis took shape or even somewhat earlier, a kind of non-Christian Gnosis known as *Hermetism* or *Hermeticism* came into being in Egypt.[1760] It was grounded in the syncretistic mystery religiosity of the late Antiquity and a somewhat Romantic-antiquarian interest in the religious traditions and wisdom of Egypt now about to fizzle out, in particular focusing on the pursuit of "the occult sciences" of astrology, alchemy, and magic. Its written output consists of a large number of pseudepigraphical writings ascribed to Hermes Trismegistus, a mythical, semi-divine sage identified with the Egyptian god Thoth. Although maybe an artificial compartmentalisation, the Hermetic writings are usually partitioned into a technical part, which consists of treatises on astrology, alchemy, and magic, and into a philosophical portion, the larger part of which was at some point in time collected into what is now known as the *Corpus Hermeticum* and which is mainly concerned with the exposition of the high-minded, albeit not very systematic, theology, philosophy, and worldview of the Hermeticists.[1761]

[1755] See [Mere80] and [Wall72] p. 100 et seqq.

[1756] See [Fowd93a] p. 134 et seqq. Plotinus opposed magic and Porphyry criticised theurgy in his *Letter to Anebo,* although he later partly tergiversated.

[1757] See [Dodd73a] p. 283 et seqq., [Fowd93a] p. 116 et seqq., [Thor23] vol. I p. 298 et seqq., [Luck89], [Nase91], and [Shaw95]. Cf. also [Luck85] p. 20 et seqq. and [BC38] vol. I p. 148 et seq. The term "theurgy" was probably coined – in deliberate contrast to theoretical "theology" – in the late 2nd century A.D. by Julian the Chaldaean, who also published the famous *Oracula Chaldaica,* so popular with the later Neoplatonists, to whom it fulfilled the need for a holy book. The theurgists were probably also, just like the Gnostics and many Jewish mystics, pre-occupied with the ascent of the soul to heaven through various gates guarded by terrible doorkeepers, to whom the correct watchwords and seals must be presented. See [Culi83] p. 11.

[1758] See [Iván64].

[1759] On early Christian mysticism and its interactions with Platonism, see [Lout99].

[1760] The most comprehensive treatment of ancient Hermeticism to date is provided in [Fest44], whereas [Fowd93a] is an interesting, more up-to-date study. See also [Reit1904], [Ziel1905], [Krol14], [Moor55], [Fest67], [Nock72], [Faiv95], [Slad93], [BH00], and [Horn01].

[1761] [Herm45] is the standard edition of the Greek "philosophical" *Hermetica,* whereas [Mahé78] collects the Nag Hammadi and some Armenian material. [Cope95] provides a translation of the philosophical *Hermetica* together with copious notes and an excellent introduction. There is no edition of the scattered remains of the "technical" Hermetica – for a brief survey of the sources, see [Cope95] p. xxxii et seqq.

The content of these philosophical works has puzzled many scholars, as it seems to expound two contradictory worldviews. Firstly, there is a group of writings, which espouse a highly optimistic "monistic-pantheistic" outlook, praising the beauty of the universe, the wisdom of its Creator, and the study of nature as an approach to God. The cosmos is depicted as good and beautiful, everywhere bearing witness of the wisdom of the one true God. In some texts, man is assigned an extraordinary position as a semi-divine being, the cynosure of the universe, to whom is granted the task of governing this wonderful world, nay even act as a co-creator working in tandem with God to perfect the world. However, another group of writings espouses a dourly pessimistic-dualistic outlook, strongly reminiscent of that of Gnosticism, where the cosmos is dismissed as a pleroma of evil and the body as a prison. Even more strangely, some Hermetic works blend both outlooks. It has recently been suggested by Garth Fowden, a leading scholar in the field, that the contradiction between the two outlooks is only apparent and reflects two stages of initiatory progress of the Hermetic 'way'.[1762] The first stage, which is echoed in the monistic-optimistic passages, centres around a kind of lower knowledge, *episteme (science),* which, being founded in reason *(logos),* lays the emphasis on God's immanent presence in his works and the need to explore the cosmos in order to understand the divine plan, whereas the dualist-pessimist passages are concerned with the higher inward knowledge of *gnosis,* understanding, for which the pursuit of *episteme* had only been the preliminaries. At the more elevated 'gnostic' stage, the initiate turns away from the world towards the transcendental realm, contemplating the divine through his own *nous,* intellect, and giving up or rejecting the abecedarian pre-occupation with *episteme* and the world as unspiritual **περιεργ□α,** curiosity. The ultimate purpose of the initiate's progress is his own rebirth by the realisation of the divinity of his own self, conceived of in the usual Gnostic manner as a spark of the divine, through which he is able to know God. In contrast, another recent student of the Hermetica, Jürg Büchli, suggests another interpretation, in which the optimistic passages are read as the response of some 'reformed' Gnosticising pagan groups to Plotin's and the Christian fathers' criticisms against the extreme Gnostic anticosmism and antisomatism.[1763]

In either construal of the Hermetic writings, Hermeticism appears much closer to Gnosticism than formerly recognised by most scholars. The Nag Hammadi findings also suggest a close relation between Hermeticism and Gnosticism[1764] and also shows that some Gnostic writings, such as the letter of Eugnostus, were produced both in pagan and Christian variants. Unlike the redeeming Christ of orthodox Christianity, the Gnostic Christ does not play any truly essential rôle in Gnosticism, but rather impersonates the rather colourless part of a messenger from the light world and a great wisdom teacher, who may easily be replaced by another teacher or messenger, such as Hermes Trismegistus – the messenger of the pagan gods – that would better fit and please an audience of a pagan rather than Jewish background. In fact, the parallel between Hermes and Christ may be more far-reaching than that, as some Stoics and Gnostics are known to have identified Hermes with the Logos, thereby making Hermes an easy choice for the rôle as a pagan Christ.[1765] Thus, one may well characterise Hermeticism as a kind of pagan Gnosis, more moderate than the most extreme antinomian Gnostic sects to be sure, but not too far removed in outlook from, for instance, the Valentinian sect, with which it has occasionally been associated by scholars.[1766] As for the development of the

[1762] See [Fowd93a] p. 95 et seqq. Cf. also [Elia78a] vol. II p. 297.

[1763] [Büch87] p. 199 et seqq. and p. 208

[1764] See [Dore86] p. 241 et seqq.

[1765] See [Fowd93a] p. 24, [Drij70] p. 195, and [Mass44] p. 384 et seq., who also mentions similar ideas about Hermes as an emanation of the Godhead, still prevalent amongst the Nusayris and Druzes of Syria and Lebanon. Casaubon actually believed that the Hermetica had been faked by a semi-Christian. See [Yate64] p. 400.

[1766] See [Fowd93a] p. 113 et seqq., p. 172 et seq., and p. xvii, where, however, the idea that Hermeticism owes anything to Christian Gnosticism is fleetly dismissed. Similarly, [Trög71] contends that Hermeticism and Gnosticism are phenomena *sui generis,* albeit closely interrelated, inasmuch as Hermeticism aims at the deification of man through the mystical assumption of a new pneumatic-divine substance, whereas in Gnosticism *the pneumatics* are deemed divine from the start and only need to be reminded about this. In contrast, [Büch87], on the basis of linguistic, stylistic, conceptual, and thematic affinities, characterises *Poimandres,* the first and perhaps most important tract of the *Corpus Hermeticum,* as "ein paganisiertes Evangelium" and concludes (on p. 210), "Er ist nun vielmehr Spiegelbild der religiösen und theologischen Strömungen innerhalb des Christentums der ersten nachchristlichen Jahrhunderte. Er öffnet uns auch den Blick auf das Gebiet der Gegenreaktion des Heidentums auf das Christentum und der Einwirkung des Christentums auf das Heidentum selber." See also [Dodd54], [Dodd68], [Pétr67], [Pétr90], [Holz94], [Wils67], [Wils71], and [Hein18]. Similarly, that the dead duck of Buddhist "influence" on the gospels, which Bible-deconstructing scholars eagerly tried to make the most of in the late 19th and early 20th century and which [Thun93] recently has attempted to revive by recourse to implausible finessing of the dating of the documents involved, was founded on parallels rather to be accounted for by Christian influence on the late Buddhist texts, where the parallels are found, has been convincingly argued by [Derr67]. See also [Garb14], [Benz51], and [Moff98] p. 24 et seqq.

Hermetic worldview, the case of Bardesanes of Edessa[1767], the founder of the Bardesanite sect, which would remain influential well into the Moslem age, and the purported teacher of the heresiarch Mani will be particularly instructive, as this "semi-Gnostic" Christian philosopher developed, from a Christian starting-point, a worldview very close to the one espoused in the Hermetica as well as in other second-century philosophy, such as the "middle Platonism" of Numenius of Apamea[1768] and the theurgic theosophy of Oracula Chaldaica.

The philosophical Hermetica, containing numerous echoes of Old Testament passages and, albeit constrained by the imaginary ancientness of their author, also rather obvious reflections of Christian sentiments and views, particularly of a Johannine ethos[1769], were read and appreciated also by many ancient Christians, notably Lactantius and Cyrillus, who fancied Hermes Trismegistus a prophet of Christianity, although other Fathers, notably St. Augustine, were rather tepid about Hermes.[1770] As a consequence of this Christian interest, many of the Hermetic treatises, particularly those of a more philosophical tenor, were preserved throughout the Byzantine era. For example, they were studied in the 12th century by the Platonist philosopher Michael Psellus, although his comments about them also reveal a considerable reserve about the qualifications of their author, the "sorcerer" (**γόης**) Hermes. During the Renaissance, the *Corpus Hermeticum,* which may be a Byzantine compilation, was brought to Florence from a Greek monastery and soon translated by Marsilius Ficino in 1463 at the instigation of Cosimo de' Medici. The Hermetica almost instantly made a tremendous impact on the contemporary intellectual world and, as we shall see later, would also provide the hotbed in which what we have been used to refer to as "the scientific revolution" germinated.[1771] Only as Isaac Casaubon had proved their late date and pseudepigraphical character in 1614, did the spell they had cast on the minds of the Western intelligentsia start to abate. Or rather, the Hermetic ideas now began to dissociate themselves from Hermes and start a new life on their own.

Although frequently denied by modern scholars, working under the modernist imperative of decrying Christianity in every other sentence and depriving it of all relevance except as the cesspool of unmitigated badness and stupidity, the aforementioned movements were all to a considerable extent shaped by the impetus and challenge presented by the Christian revelation and profoundly affected by the change in consciousness brought about by the Christian experience of faith. Albeit reacting against the rising tidal wave of Christianity by an attempt to preserve a legacy, or rather portions of a legacy, which their champions perceived as indispensable, these movements all shared to a greater or lesser extent in the Christian alterations of sensibilities, such as the new emphasis on moral purity, the otherworldly, and the holy, the yearn for direct communion with the one God, from whom all and everything ultimately derives, the thrust towards interiorisation and conscience-based ethicality, the spiritualisation of this ethicality – largely the result of the Christian heightening of the aspiration to goodness and addition of the Christian virtues to the old philosophical ones – as well as the accompanying amplification of the sense of moral responsibility and ethical seriousness.[1772] Christianity and its malcontents also shared an essentially similar hierarchical worldview with the one God at the top, the intelligible realm emanating from Him a little below, and the sensible realm nethermost, between which the celestial regions populated by angelic or divine beings were interposed.

Nevertheless, there were of course also significant differences. Firstly, none of these alternative interiorist movements accepted the Christian conception of the Fall of Man and the Original Sin, or the Christian intensification of the ethical imperative beyond human capability, but instead opted for a more "humanistic" outlook, where man would appear in a more favourable light, being relieved of the brunt of the blame for the evil in the world and held to be a perfectible, albeit imperfect, kind of being, essentially good. The mystery of the incarnation, the belief in Christ as the revelation of the One God in human shape, also sets the Christian

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[1767] See [Drij66], [Teix92], [Scha32], [Drij67], and [Drij70].

[1768] Numenius, who was the teacher of Galen, is usually considered the most important precursor of Neoplatonism; Plotin was even accused of plagiarising him. Numenius, like other Platonists of this time, such as Galen and Celsus, was by no means ignorant of Christianity. Cf. also [Dörr76] p. 491 et seqq. and [Omea82].

[1769] On the Biblical allusions see, for instance, [Büch87], [Pear81], and [Fowd93a] p. 36 et seq. Cf. also [Idel88].

[1770] See [Fowd93a] p. 196 et seqq. Cf. also [Broc83].

[1771] See [Cope95] p. xlv et seqq. for an exposé of the historical fortunes of the *Hermetica.*

[1772] See [Büch87] p. 203 on how Hermeticism absorbed and transformed Christian themes.

conception of God apart from the more abstract-theoretical conception of God that was shared to some extent by all the others, but was the particular hallmark of Platonism.

Another issue, which distinguishes Christianity from the pagan and Jewish counter-movements, was its very firm rejection of the 'occult sciences'. We have already mentioned the temptation of Christ as paradigmatic for the Christian dismissal of magic. In the *Acts of the Apostles,* there are a number of passages that well illustrates the Christian dismissive attitude towards magic, viz. St. Paul's encounter with the Jewish magician Barjesus, St. Peter's confrontation with Simon Magus, and the burning of sorcery books in Ephesus, where the drastic consequences of the rejection of occultism are clearly spelt out, "Many of them also which used curious arts brought their books together, and burned them before all men: and they counted the price of them, and found it fifty thousand pieces of silver."[1773]

In the ancient world, nothing like "science" in the modern sense of the word, i.e. as a pursuit undertaken by large bodies of highly specialised professional "scientists", who work for big research institutes and academic institutions and publish their results in scholarly journals, existed, although there were a few sizeable centres of learning, such as those at the famous libraries of Alexandria and Pergamum and, of course, the philosophical schools in Athens. Significantly, the modern boundaries between philosophy and science, between theology and science, between the various individual sciences, and, notably, between the 'occult sciences' and the 'sciences proper' did not exist either, or were only very vaguely felt.[1774] So, mathematics, numerology, astronomy, and astrology were from earliest times more or less all of a piece and remained so until the 18th century.[1775] Alchemy was at the same time both a practical and a mystical pursuit, indistinguishable from 'scientific' chemistry and metallurgy.[1776] Natural history was largely concerned with mirabilia and curiosities, strange magical recipes and secrets, and suchlike, as anyone who has browsed the pages of Pliny's huge work in this genre will know. Although magic was widely abhorred amongst cultivated people, at least as far as lip service goes, and penalised with capital punishment both in the Roman Empire and in Plato's ideal state, it enjoyed considerable popularity throughout Antiquity.[1777] Whereas Plotinus had

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1773 *Ap. Act. 19:9.*

1774 For example, [Lloy79] (oddly followed by [Tamb90] p. 8 et seqq.) tries to drive home the anachronistic thesis that the starting point of Greek 'science' was a fundamental opposition to magic and commitment to reason, making his case on the basis of little more than a single piece of evidence, viz. the Hippocratic treatise *De morbu sacro.* But, firstly, almost the entire ancient world, as indeed all mankind, was opposed to the *practice* of magic, or, to be more precise, the practice of magic for malicious purposes, which, also being heavily penalised in the legal systems of most states until very recently (cf. [Lieu85] p. 142 et seqq.), was a topic largely avoided in civil discourse and all but unanimously stigmatised by those who cared to comment upon it. Secondly, there was an almost as unanimous belief in the efficacy of magic *in principle* – and, thus, also in the notions of demonology and sympathy underlying it – amongst those who cared to comment about *it,* be they 'scientists' – to use a 19th century term unknown to the ancients – or commoners. Discussing the Hermetic treatises on magic, science, and astrology, [Fowd93a] p. 76 aptly remarks, "The technical Hermetica build on the disinterested investigation and classification that had been the hallmark of Aristotelian science". In short, there was no gulf between ancient 'occultism' and ancient 'science' – such a notion is simply a projection of the outcome of Enlightenment rationalism onto ancient Greece. Cf. also [King95a] and [King99]. On the division line between religion, science, and magic in general, see also [NFM89], [Tamb90], and [Cunn99]. The scholarly literature on ancient 'science' is too unwieldy to be discussed here; a recent survey is provided by [Rihl99]. Well-established survey works are, for example, [Lloy70], [Lloy73], [Sart70], [Sant61], [Neug69], and [Farr65]. On the occult sciences in general, see [Thor23], [Fest44], [Luck85], [Cumo56] p. 162 et seqq., [Fowd93a] p. 75 et seqq., [Kies1896], and [Shum72]. Cf. also [Maxw99].

1775 On the history of astrology, see [Test87], [Lind71], [Cumo12], [Cumo60], [Bouc1899], [Maur78], and [BBG77].

1776 See [Coud80], [Holm90], [Sher76], [Robe94], [Gebe00], [Elia78b], [Read63], [Read66], [Burl68], [CH61], [Burc86], [Pata94], [Haag00], [Wils84], [Ganz38], [Ganz56], and [Latz]. Cf. also [Jung68]. Differing views as to the origin of alchemy are found in, for example, [Well28] (Bolus of Mendes ca. 200 B.C.), [Luck85] p. 362 (Hellenistic Egypt "as a result of an exchange of ideas between Egyptian practitioners and Greek scientists", probably supplemented by an influx of ideas from Mesopotamia), [CH61] p. 103 et seqq. (an ancient Pelasgian metallurgic priesthood in charge of mystery cults such as those of the Samothracian Cabiri), [Dubs61] (the Chinese philosopher Dzou Yen living in the 4th and 3rd centuries B.C), and [Shep57] (Alexandrian Gnosticism of the 2nd century A.D.). The alchemists themselves tended to attribute their art to such figures as Adam, Tubal-cain, Enoch, Ham (the son of Noah), the (fallen) angels, Hermes Trismegistus, or the Persian Magi – in the case of the Magi usually through the intermediation of the Greek philosopher Democritus, who was believed to have learnt the art from Ostanes, a Persian magus of noble birth accompanying Xerxes during his campaign in Greece (see [BC38] vol. I p. 167 et seqq. and [Pata94] p. 18 et seqq.). In [PN01], two leading scholars of the field criticise the prevalent "spiritual" and Jungian conceptions of alchemy, arguing that the alchemists' extravagant imagery was but a secretive cloak for chemical recipes (cf. also [Prin98] p. 188 et seqq.).

1777 On magic in the ancient world, see [Graf96], [Leno99], [Sega81], [Gres88], [Lowe29], [Well28], [Thor23] vol. I, [Flin91] p. 13 et seqq., and [Stoy00] p. 119 et seqq. Jewish magic is surveyed in [Blau87] and [Trac39]. On the Persian magi, see [Jong97] p. 404 et seqq. et passim. Ample samples of the praxis and theory of ancient magic are found in [Betz86] and [BC38]. [Maur78], [Cave78], and [McIn85] outline the history of magic from the early times up to now.

been hostile to Gnosticism and the occult pursuits associated with it, the higher magic of theurgy, cultivated, intellectualised, systematised, and propagandised by Gnostic-Hermetic circles, became all the rage in late Antiquity amongst Neoplatonist intellectuals and also penetrated into Jewish mysticism, as witnessed by the famous Golem stories.[1778] Notably, the borderline between illicit magic and licit theurgy always was fuzzy, allowing considerable percolation between the two. Thus, the modern projection of present-day science and rationalism on Antiquity, nay on the entire period preceding the 18th century, by necessity produces an altogether skewed picture of the true state of affairs. For in reality, there did not exist anything even vaguely reminiscent of modern science before the 17th century and, in particular, there was no fundamental animosity between science and occultism or, for that part, between science and theology in ancient times.

But through the arrival of Christianity, an attitude of more profound unease with the occult started to become widespread, as the occult practices seemed to hinge on the pagan veneration of demonic-divine beings, astral gods, and spirits, with whom a pious Christian should by no means traffic. Astrology was further compromised by the fatalism it seemed to imply, which clashes with the Christian assertion of man's free will and responsibility for his own deeds.[1779] In this context, it may be interesting to note that whereas the Neo-platonists, despite their basic monotheism, defended the cult of the old gods and spirits whom they held to have been allotted the authority of their respective domains from of old, the Christian and Jewish religions de-divinised the world not primarily by denying the existence of these "principalities and powers", but by rejecting their goodness and their title to be worshipped by man.[1780] For example, Justin Martyr declared one of the main reasons for Christ's incarnation "the destruction of the demons", which he, as commonly made in the early Church, identified with the pagan gods and held to be the offspring of the fallen angels mentioned in *Genesis,*[1781] and Eusebius, in his oration in praise of Constantine, summed up the deliverance from the pagan bondage under the demonic brought about by Christ thus succinctly: "He who is the common Saviour of mankind, by his invisible and Divine power as the good shepherd, drives far away from his flock, like savage beasts, those apostate spirits which once flew through the airy tracts above this earth, and fastened on the souls of men".[1782]

On the face of it, Gnosticism might seem just to have radicalised the Jewish-Christian "sedition" against the pagan gods by denying the goodness also of the Creator of this world Himself and His claim to worship. To the Gnostics, the material cosmos in its entirety was a trap ruled by the tyranny of fate, *heimarmene,* through the unpropitious astral-planetary influences of the demonic "principalities and powers". But as they rested assured that man by the pursuit of magic and the other occult sciences could wrench himself free from the grip of destiny and the despotic archons resident in the heavens and start to bend these powers to his own advantage and will, they did not, like the Christians, reject the occult trafficking with demons and spirits, but rather tended to plunge into it headlong. As a matter of fact, it is amongst the Gnostics we encounter the root of the synthesis of the will to power and the cult of knowledge that constitutes the underpinnings of modern Western science and technology.

Hermeticism, albeit *prima facie* considerably less gloomy in outlook than mainstream Gnosticism, by and large shared the Gnostic worldview and, with it, the devotion to the occult sciences, which, loosely forged together as 'the Hermetic sciences', seem to have been transformed into a 'way' to spiritual 'enlightenment'. Although the pursuit of the occult was deeply problematic in Neoplatonism and Jewish mysticism, which both were fundamentally at loggerheads with the Gnostic anticosmism and astrological fatalism and suspicious of the ethicality of the occult in general, these movements could in the end not resist its allure, and over time absorbed many of its ideas and practices, albeit often in a refined, somewhat expurgated form. Additionally, Neoplatonism and Hermeticism more or less tended to merge during late Antiquity, providing a kind of last pagan citadel against Christianity, devoted to the cult of the old gods and demons, the communion with them

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[1778] On the Golem, see below p. 480.

[1779] See [Lais41] and [Thor23] vol. I p. 513 et seqq. and p. 672 et seqq.

[1780] Cf. [Voeg87] p. 100 et seqq., [Dodd70], and [Fric75] vol. I p. 156 et seq. See also [Schl61].

[1781] *2 Apol. V-VI.* Cf. also *Gen 6.*

[1782] *II.3* as translated in [Euse97] p. 583. On the conception of these powers in the New Testament, see [Schl61] and footnote 2423 on p. 522 below.

through theurgy, the pursuit of the sciences – occult or not–, and the preservation of the philosophical legacy of the Academy, the Lyceum, and the Stoa.

Against both the pagan cleaving to the old religion with all its bottomless depravity and the wholesale Gnostic rebellion against God and the entire created order on the basis of surrealist fables and strange pipe-dreams about a pleromatic Cockaigne beyond the heavens, the Christian Church struggled to pursue the way of sanity and sanitisation, devoting itself to the difficult, but necessary task of the discernment of spirits, sifting the spiritual wheat from the chaff, dismissing the obviously depraved and evil, replacing the dubious with salubrious Christian counterparts, and claiming what was good and reasonable in the pagan legacy as truly Christian, in effect the work of the Logos, according to the principle so well formulated by Justin Martyr, "whatever things were rightly said among all men, are the property of us Christians"[1783]. The significance accorded to this task by pious Christians is reflected in the fervour of the dogmatomachies that surrounded the councils of the Church, so often thoughtlessly derided by present-day academic wags. As Antiquity drew to its end, the small pockets of opposition against Christianity – Jewish traditionalism and mysticism, pagan Neoplatonism, and Gnosticism of both the heterodox pseudo-Christian and the pagan-Hermetic variety – may seem to have dwindled into insignificance, at least when compared to the Christian Church. But the Christian hegemony would soon turn out to be but appearances and the anti-Christian currents were later to regain their vitality with a vengeance. Additionally, the seemingly victorious Christian Church was internally deeply divided by the dogmatomachies between the "Melchite" orthodoxy, the Syrian rationalist-Aristotelian Nestorianism, the Egyptian mystical-Platonic Monophysitism, and the Arianism still popular, albeit on the decline, amongst the Goths, and all attempts at reconciliation between the competing branches foundered. Additionally, a new and formidable danger was soon to loom large.

[1783] *2 Apol. XIII*

> *In the early days of Islam, after the times of the Orthodox Caliphs (God's blessing upon them all!), there appeared amongst the Moslems a sect of people whose minds had no sympathy with Islam and in whose hearts there was rooted a fellow-feeling with the Magians.*
>
> *Juvaini*[1784]
>
> *… as night faded the Master assured his successor that as long as he proved worthy of his charge, his spirit would counsel him. It is even related that he whispered to him to remember that nothing was true, that everything was permitted. Thereupon, according to the Sunnite historian Juvaini, he departed for Hell.*
>
> *Enno Franzius*[1785]

Quite similar to the way the Germanic Invasions had swept the North-western part of the 'civilised world' and dissolved the established order during the preceding centuries, in the seventh century the victorious armies of Islam all of a sudden came over the South-eastern part of it, engulfing Sassanid Persia altogether and squeezing the Byzantine residue of the Roman Empire into a gradually shrinking corner of Eurasia, wedged between the Saracens, who persistently attacked from the Southeast, and the Bulgarians and various other peoples, who pressed on hard from the North.[1786] The time recording of the Moslems starts in the year 622, when Mohammed fled to the city of Medina (the *hidjra),* where he and his supporters soon gained control. In 630 Mecca was captured and in 632, at Mohammed's death, large parts of the Arabian Peninsula had already been subdued by his troops. During the following years an unheard-of series of military victories were gained by the supporters of the new religion. In 635 Damascus fell, in 638 Jerusalem, in 642 Alexandria, in 643 Ispahan, and in 651 all of Persia had been conquered. In 711 the prophet's bellicose followers passed the Straits of Gibraltar, and a few years later they had all but subjugated the entire Iberian Peninsula.

By analogy with the Enlightenment, which often has been interpreted as the reaction to the excesses of the preceding religious wars, the rise of Islam can be construed, at least partially, as a response to the tensions in consciousness – as well as in the physical world – created by the division of the Christian Church into the contending parties of the Melchites, Nestorians, Monophysites, Arians, and various other minor groups. As perceived already by St. John of Damascus, the first important Christian critic of Islam, this new religion is any case a Christian heresy, transformed into a new religion by the course of events. A heresy it is *per definitionem,* as Mohammed *de facto* picked out from Christianity what seemed to make sense to him, although we should beware of understanding this process of adaptation in too rationalistic terms – after all, Mohammed received most of his proclamations through auditions, which he himself believed to derive from the angel Gabriel, who had appeared to him, he claimed, in the mighty vision, through which he was summoned to become the prophet of Allah.[1787] Probably influenced by the Ebionites' Judaizing views, which he by and large seems to

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[1784] [Juva97] p. 641 (III.VIII.142).

[1785] [Fran69] p. 67. The Assassin "Master" Hassan Sabah's infamous catch phrase "nothing is true, everything is permitted" is not in Juvaini (see [Juva97] p. 682 et seq.). In [Hamm1818a] p. 84, von Hammer-Purgstall calls this dictum "der Grund der geheimen Lehre" (viz. of the Assassins) without attributing it to Hassan Sabah specifically (cf. also id. op. p. 56). Nietzsche, by citing it ("nichts ist wahr, alles ist erlaubt") as an Assassin motto in *Zur Genalogie der Moral 3:24* and contemplating it in *Also sprach Zarathustra* (in the chapter "Der Schatten"), doubtless strongly conduced to its propagation as a jingle of fin-de-siècle nihilism. The association of the dictum with Hassan Sabah, the founder of the Assassin sect, seems to have been popularised in countercultural circles by the ostentatiously depraved beat poet William Burroughs, who reportedly took a strong interest in the Assassin legend in general and the figure of Hassan Sabah in particular, and by the archanarchist Robert Anton Wilson's Illuminati novels (some of which were co-authored by Robert Shea). The saying is nowadays commonly cited with approval by the spokesmen of all kinds of 'deviant' phenomena and behaviours, of postmodern nihilism, and, more generally, of the entire modern destruction of traditional philosophy, theology, religion, and ethics.

[1786] By necessity, we can only touch on the vast subject of Islam, its doctrines, development, and history very lightly. The *Encyclopaedia of Islam* is an invaluable asset to the inquirer into these topics. Two survey works I have found particularly useful are [Hjär79], a brief introduction to Islam as a religion, and [Hodg74], a comprehensive treatment of its historical and civilisational dimensions.

[1787] See [Hjär79] p. 38 et seqq. There are striking similarities between Mohammed's vision of an angel "Gabriel" of huge dimensions and the angelic vision seen by Elchasai, the founder of the Elcesaite sect, who reportedly received the contents of the *Book of Elchasai* from "the Son of God", an "angel ninety-six miles high, sixteen miles broad, and twenty-four miles across the shoulders, whose footprints were fourteen miles long and four miles wide by two miles deep" (see [Chap09a]). From ancient times up to present-day UFO cults, many

have adopted, he set out to simplify Christianity by doing away with what he, apparently, perceived as its chief problems.[1788] In this endeavour he showed a strong tendency towards commonsensical simplification[1789], a liking for the colourful, plastic, and spectacular, and a striking lack of sensitivity for the mysterious and philosophically subtle or profound. He liked the figures of Jesus and Mary, but could not accept the divinity of Christ, whom he instead made into a prophet and predecessor of himself. While he characteristically accepted the virgin birth of Christ, His ascension to heaven, and His position as the Judge of mankind, he dismissed His Resurrection and could not accept that Christ had been nefariously crucified, but, like the Gnostics, held that someone else had died on the cross in His place. He brooked no philosophical niceties and thus rejected the central Christian dogmas of the Holy Trinity, the two natures of Christ, and the Original Sin, being adamant on the absolute unity of the Godhead and maintaining the basic goodness of man.

He also addressed what he saw as the problems of Christian ethics in a similarly simplistic way and, having dismissed the morality based on the "law of freedom" and the reform of man's heart through the Christian virtues of faith, hope, and love, instead ventured to restore the kind of casuistry based on the *lex talionis* characteristic of the Mosaic religion. Also the exterior attributes of Islam were largely defined in reaction to Christianity and, to a lesser extent, Judaism so as to emphasise the view that Mohammed was a *new* prophet, whose revelation was now to supersede and correct the outworn dispensations of Christ and Moses, just as the revelation of Christ had superseded that of Moses. The sacral architecture of Islam, the elevation of Mecca to the status of a Holy City instead of Jerusalem, the choice of Friday instead of Sunday (or Saturday) as holiday, the reliance on the muezzin instead of the bell (or the horn) to call together the faithful to the divine service, the ostentatious expressions of prayer instead of the Christian emphasis on non-ostentation in the religious life, and many other characteristic Moslem practices all serve to underline the distinctiveness of the new revelation of the Koran and to set apart the new era of absolute *submission,* Islam, to God and his prophet from the Christian interlude of *love* and reform of heart. Just as was the case with Monophysitism, Nestorianism, and Arianism, there are certainly also nationalist overtones to Islam, clearly to be perceived, for instance, in the significance accorded to Mecca as the centre of the new religion and to the Arabic tongue as the holy language of the Koran.

Whereas Christ, having chosen the way of the cross and withstood the devil's offer of worldly power and riches, could insist that God's Kingdom was not of this world, Mohammed's definitely was. Recoiling at the spirit of otherworldliness typical of both Christianity and late Antiquity in general – escalated to the most unconscionable heights of anticosmism and antisomatism by Mani and his followers –, he deflected the transcendental hopes for salvation into utopian ones, offering a vision of innerworldly perfection to be brought about by the adoption of Islam and adherence to its holy law, *sharia.*[1790] The prophet also showed

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founders of new religions and sects have based their authority on visionary experiences of purportedly divine or angelic beings, from which they then often start to receive "channelled" messages (see [Hast91] p. 171 et seqq., [Evan84], and [Evan87]). For example, Mani, who was brought up an Elcesaite, claimed to have been instructed by his "syzygos" or divine twin (see [Lieu85] p. 32 et seqq.), Sheikh Adi, the founder of Yezidism, by the peacock angel Melek Taus, a.k.a. Azaziel or Satan (see [Gues87] p. 31), Joseph Smith, the father of Mormonism, by 'heavenly beings' (see [Wood20] p. 85), and C.G. Jung by the winged spirit guide Philemon (see [Noll97]). Besides by such Biblical passages as *2 Ep. Cor 11:14, Ep. Col. 2:18*, or *1 Ep. Jo. 2:1-3,* to say nothing about the gospel narratives of Christ's temptations, the critical Christian attitude against the undiscerning endorsement of such experiences and the messages conveyed through them is strikingly epitomised by the story of the conceited hermit Valens' spurious vision of Christ and a thousand angels in section XXV of Palladius' *Historia Lausiaca* [Pall12].

1788 See [Fahd95] p. 676 and the further references to the literature given there. Cf. also [Andr26] and [CC80].

1789 This is pointed out in [Bell91] p. 40 et seqq.

1790 Manichaeism constitutes an important part of the backdrop against which Islam rose. Firstly, there are some striking similarities between Mani's and Mohammed's views, such as the docetic interpretation of the crucifixion of Christ, the relativisation of the Christian gospel by the demotion of Christ into one prophet amongst many, whose teachings are now to be superseded by those of the new – and presumably last – prophet Mani or Mohammed, the way in which the revelations are imparted to them by angelic visions, and the preservation of the eschatological function of Christ as the Messiah and Judge of the World. But on other counts, Mohammed seems to react against and take issue with Mani. Mohammed's fundamentally anti-Gnostic attitude is entirely at odds with Mani's extreme anticosmism and antisomatism, his notion of *jihad* and a utopian Islamic society clashes with Mani's anarchistic pacifism, his predilection for Judaizing casuistry largely reverses Mani's rebellious and basically antinomian asceticism, and his strong anti-asceticism contrasts starkly with Mani's castigation of meat eating and procreation, although both agreed on the prohibition of the consumption of wine. On the possible influence of Manichaean notions on some passages in the Koran, see [Stoy00] p. 111. Rather strong Manichaean doctrinal influences can be perceived in some heterodox Moslem sects and, in particular, in Ismailism. Manichaeism and its various derivatives universally met with very strong reactions, and Manichaeism doubtless is one of the most execrated and persecuted religions of history. Persian, Roman – pagan as well as Christian –, Byzantine, Arab, Chinese, and medieval Western ecclesiastic and secular authorities all took harsh steps

great prowess and clear-headedness in identifying and suggesting medication for the sore spots in the socio-economic body, skilfully regulating social matters and state affairs so as to promote the power, wealth, and popularity of Islam, its devotees, and, certainly also, himself. To this thisworldliness he, probably animated by the Messianic-apocalyptic expectations of various Jewish and Judaizing Christian sectarians, wedded an intense apocalypticism, considering himself the "seal of the prophets" and "the messenger of the end times", which were now imminent, nay, had already begun at the battle of Badr in 624, where according to the Koran 3000 angles accompanied him in the fray, and was expected by many early Moslems to culminate in 717.[1791] Feeling a strong aversion for asceticism, celibacy, and monasticism – the way of the cross –, he instead fatefully chose to funnel the quest for the Divine Ground, the strongest energy there is in man, into the conduit of holy aggression through his conception of *jihad* ("struggle"), the way of the sword, to which he added even more brio by his immanentist conception of the eschatological events.[1792] In addition, his by-laws for Islamic missionary warfare, cunningly thought out so as to promote the cause of the Moslems, promised freedom from debt and thraldom to all converts to Islam and exemption from looting and expropriation to peoples that surrendered to the Moslem troops, whereas the Moslem conquerors were regaled with the spoils and landed property captured from the infidels who insisted on being vanquished in combat. He also made it impossible for the Moslem proselyte to repent and revert to his former religion, draconically penalising such tergiversation with capital punishment. The combination of religious-apocalyptic energy transformed into pleonectic military-politic aggression through a system of alluring material incitements and terrible deterrents, carefully designed so as to foment the fierceness of the Moslem armies and instil defeatism amongst their victims, doubtless was the chief factor of success behind the hectic expansionism of early Islam, presenting the Christian world with a more deadly threat than even the Roman emperors' ruthless persecutions had been able to do. In this extreme religious-military activism we may also perceive the impact of the Gnostic idea of self-salvation, albeit partly transposed to the immanent plane: Man can himself ensure his own salvation by taking part in jihad, the Holy War.[1793] Thus, Mohammed took a crucial step towards what Voegelin called *immanentisation,* the thrust from the transcendental and otherworldly towards the immanent and thisworldly.

This shocking experience forever changed the Christian nations, weighing heavily on the original Christian cheerfulness and undaunted otherworldliness, insofar as these had been heartened by the successful and comparatively easy dissemination of the "good news" of the gospel of love over the world. It forced the Christian states into an attitude of increasing defensiveness, militarism, and concern with worldly and political matters at the expense of the spiritual-ethical issues that constitute the true nub of the Christian religion – and, alas, largely also into the imitation of the bellicose and heavy-handed ways of their formidable foes. So the Franks, in order to save the Christian world from the onslaught of the Moslems, Vikings, and Langobards into the very heartland of Christian Europe during the early Middle Ages, had to invent feudalism, restructuring society so as to be able to produce an efficient cavalry.[1794] The feudal re-arrangement of society more or less necessitated the adoption of various other innovations, such as windmills and water-mills,[1795] and, thus, the pressure from the outside fomented an increased openness to technical novelty in the Western hemisphere that was not shared, at least not to the same extent, by the more traditionalist Eastern Christianity and later would turn out to unfurl in the most unexpected and dramatic manner.

With some provisos, it will be possible to read the subsequent history of the West as a process of surreptitious, but steadily accelerating 'Islamisation' that begins very early, albeit at first almost imperceptibly

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against them. Their excessive asceticism and asocial proclivities, their shocking mythology, their alleged proficiency in sorcery and the other occult arts, which exposed them to the indictment of *maleficium,* and the dark rumours – the veracity of which is still being quarrelled over – surrounding so many Gnostic sects throughout history concerning unspeakable depravities, such as secret orgies spiced with ritual infanticide and cannibalism, all conduced to their extreme unpopularity; see [Lieu85] p. 91 et seqq. and [Stoy00] p. 112 et seqq.

1791 See [Arjo98], who also points out that the apocalyptic aspect of early Islam has been almost totally neglected in modern historiography. Cf. also [Lewi50], [Cook01], and [Schl18]. According to [CC80], early Islam emerged from Arab-Jewish "Hagarism" fuelled by Jewish irredentism, Messianism, and dreams about the restoration of the Temple.

1792 On the idea of holy war inside and outside Islam, see [Tyan65], [Noth66], [KJ91], [Colp94], [Pete96], and [John97b]. [Fire99] argues that the idea of holy aggression has not been unanimously accepted amongst Moslems, not even by the prophet's first supporters.

1793 Cf. [Maur83].

1794 The success of the Frankish cavalry has been attributed to the use of the stirrup, a newly arrived innovation, possibly adopted by them from the Avars or the Byzantines. See [Whit62] p. 1 et seqq., [Whit78] p. 278 et seqq., and [Sloa94].

1795 See [Whit62] and [Gimp77].

and mainly at the frontiers between the Christian and Moslem worlds, gains momentum through the influx of Islamic philosophical and 'scientific' writings and technical innovations as well as other cultural contacts during the High Middle Ages, becomes more and more limpid during the Renaissance and Reformation – in particular, the striking structural likeness between Calvin's Reformed Church and Islam has often been pointed out[1796] – and culminates in modernism, which deforms and radicalises the immanentist thrust implicit in Islam into a rampant materialism and total abnegation of not only the Christian religion, but of all religion, totally at odds with Mohammed's intentions and the spirit of the religion he gave rise to. This process, which, of course, is not to be understood in terms of a simplistic wholesale adoption, but rather as a meandering flux of assimilations, diffusions, mutations, and modifications, would later be reflected in the ever-increasing emphasis on the outward, political, and national, in the accompanying insistence on conformance and control also when this implies the use of violence, and in relentless technological, political, and military expansionism, that is to say the enormous Faustian escalation of the *libido dominandi* that is a *de rigueur* component of all worldly power – after all the name of Mohammed's new religion was *Islam, submission* – as against the Christian ethos of *fides caritate formata,* faith formed by love, and life as a quest for the Kingdom of God *inside* man through the life of the spirit, loving concern for one's neighbour, and good works together with the concomitant dismissal of the significance of power, wealth, politics, and the kind of issues Mohammed had brought to the fore. In such an interpretation of the history of the West, one might be tempted to make Napoleon's baffling confession, made in Egypt in 1797, that he also was a Moslem one of the great revelatory events in Western history.[1797] Somewhat ironically, at the same time as the West took on the extrovert, sensate ways of its Moslem foe, the Moslem world grew increasingly introspective through the rejection of the theologically risky strains of philosophy and science and the concomitant growth of Sufi mysticism[1798], suggesting that the above interpretation may be too one-sided and that we must take a closer look at the Moslem world to appreciate the impact it has had on the West. As we will see below, it would be a mistake to look at Islamic culture as monolith; rather it must be realised that Islam was a ferment of very diverse ingredients, some of which would only show their full potential in the West.

The rapid expansion of Islam also implied that a great number of people was presented with the stark choice between death and the adoption of Islam or, in case they could be classified as Christians, Jews, or Sabians[1799] rather than idolaters and had some good luck at that, with the choice between death or the disbursement of a heavy tax. Those not willing to die, or not having the wherewithal to pay the tax, had to become Moslems. And even those who were able to save their own skin by paying became a kind of second-rate citizens, having to put up with the endless harassment, discrimination, massacres, and other tribulations institutionalised by the Moslem *dhimmi* system.[1800] The practice of forced conversion together with the general disaffection of the non-Arabic converts to Islam, the so-called *malawis,* toward the Arab dominance naturally fomented dissimulation, providing the backcloth for the proliferation of sects, esoteric coteries, and secret societies, which, while outwardly conforming to and asseverating their allegiance to Islam, entertained secret beliefs, often of a syncretistic-Gnostic character, that deviated markedly from mainstream Islam or were altogether at loggerheads with it. Amongst the Shiite Moslems, such dissimulation was even transformed into

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[1796] See, for example, [Bell91] p. 44 et seqq. The similarities between Protestantism and Islam were pointed out already by Guillaume Postel, the mystic and Orientalist contemporary with the Reformers, in his *Alcorani seu legis Mahometi et Evangelistarum concordiae liber* (see [Bouw57] p. 10). Cf. also [Mais80] vol. II p. 241 et seq.

[1797] See [Godw94] p. 106.

[1798] On Sufism, see, for example, [Knys00] or [Schi92].

[1799] The Sabians are mentioned together with Christians and Jews in the Koran as *ahl al-kitab*, peoples of the book considered followers of legitimate prophets preceding Mohammed. As such, they enjoyed the privilege of not necessarily being butchered if they refused to convert to Islam. Sundry religious minorities claimed – with varying degrees of success – to be Sabians, including the pagan-Hermetic astrolaters of Harran, the Gnostic Mandeans, and the Zoroastrians. See [Chwo1856], [Gree92], [Hjär72], [Fahd95], [Tuba86], [Fowd93b] p. 62 et seqq., and [Eise97] p. 328 et seqq.

[1800] On the hardships of Christians, Jews, and other non-Moslems in the Moslem world, see [Yeor91]. Cf. also [Lewi53] on heresy and heresy hunting in Islam. A regular Inquisition was set up by the Abbasid caliphs already in the 8th century in order to extirpate the *zindiqs,* the Manichaean dualists, who had been severely persecuted already by the Persian and Roman authorities from the 3rd century onwards. In the 13th century, their Cathar descendants provided the incentive for the formation of the Inquisition of the Roman-Catholic Church.

the religious principle of *taqiyya,* the right to conceal one's conviction, lie, and refrain from one's own cult when necessary because of adverse circumstances and a hostile ambience.[1801]

Of special interest in this context will be the Ismailis, a Shiite-Gnostic sect, which arguably played a curious and crucial rôle – not always appreciated – in the formation of the Faustian spirit now usually associated with Western Europe.[1802] The Shiites originally was the party *(shia),* which supported the caliph ('lieutenant', viz. of Mohammed) Ali, the son-in-law of Mohammed, married to the prophet's daughter Fatima, deeming him and his descendants the only legitimate *imams* or 'rightful spiritual leaders'. One of their greatest triumphs was the overturn in 747-750 of the Umayyad Arab dynasty of Sunni Caliphs, who resided in Damascus, and the establishment of the Shiite caliphate of the Persian Abbasids based in the new capital Baghdad. However, the Abbasid caliphs, famous for their magnificent court and their promotion of culture, science, and learning, soon, to the grief and disappointment of the Shiites, converted to orthodox Sunnism and also started to persecute religious dissidents, most notably Manichaeans – the so-called *zindiqs*[1803] –, thereby providing one important incentive for the foundation of the Ismaili sect. Every now and then, the Shiite party *(shiat Ali)* split over dynastic issues, becoming divided into a growing number of sects, of which the Ismailis or "seveners" constituted one of the main branches, supporting the claims of Ismail (and/or his son Mohammed), the oldest son of the sixth imam Djafar al-Sadik, who when he died in 765 A.D. had, against the rule book according to the Ismailis, appointed his younger son Musa rather than the rightful heir Ismail (or, according to some, Ismail's son Mohammed) his own successor.[1804] Musa was acknowledged as imam by the larger portion of the Shiites, known as the Imamis, Ithnaasharis, or "twelvers", to which most of the Shiites in Iran and Iraq today belong. The Ismailis have subsequently split several times, and, as they generally have held the imam to be the infallible, sinless, and omniscient spokesman of God, or even an emanation of God, the fervour of their dynastic quarrels has often been considerable. Today, many Ismailis recognise Aga Khan as their imam.

During their heyday, which roughly can be said to have lasted from the middle of the 9th to the middle of the 13th century, when the Mongols shattered what was left of their former power, the Ismailis evinced an uncanny energy through their various activities, which in many respects seem to prefigure the modern project. The earliest history of the sect, which is more or less indistinguishable from the groups called *ghulat,* "extremists", by orthodox Sunni and twelver Shiite theologians,[1805] largely remains clouded in mystery[1806], but

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[1801] See [Kohl95] and [Gold1906]. It should be noted that whereas telling the truth was the fundamental virtue of ancient Zoroastrianism, Manichaeism accepted that its adherents disguised their faith in case of danger (see [Lieu85] p. 113). Before the arrival of Islam, both Zoroastrianism and Manichaeism were strong in most of the areas where Shiism would later become predominant and, thus, influenced the Shiite sects in various ways.

[1802] Short introductions to the history of the Ismaili movement together with further references to the literature can be found in [Halm91a] p. 156 et seqq., [Made78a], and [Orms85]. An excellent, comprehensive study of Ismailism and its history is provided in [Daft90]; [Daft98] is a shorter account by the same author. See also [Lewi40], [Ster83], and [Daft96].

[1803] This derogatory term is often used loosely in the sense of "free-thinker". Another such term is *mulhad,* "atheist".

[1804] According to some sources, Ismail had predeceased his father and his son Mohammed was, thus, the one wronged by Djafar's bestowal of the imamate upon Musa. Mohammed is reported to have died a prisoner of Harun al-Rashid, the most famous of the Abbasid caliphs.

[1805] See [Hodg65b], [Halm82], [Halm91a] p. 156 et seqq., and [Moos88]. Of the still prevalent *Ghulat* sects the currently most important will be the Syrian Nusayris. Orthodox Moslem theologians generally accuse these sects of three chief errors: *Hulul,* the theory that God is incarnated or infused in the imam, a doctrine often combined with some kind of docetism; *tanasukh,* the belief in reincarnation; and *ibaha,* antinomianism. These doctrines are arrived at through the spiritual interpretation, *tawil,* of the inner meaning, *batin,* of the Koran, as opposed to the revelation, *tanzil,* reflected in the literal exegesis, *zahir,* favoured by the orthodox. Fundamental to all Shiite *ghuluw* (extremism) as well as Ismailism is the idea that the inner truth of all religious revelations, which are often held to occur according to some complex cyclical scheme, is a kind of pre-Moslem Gnosis. Interestingly, at about the same time as the first flourish of the *ghulat* sects the dualist Paulicians also prospered at the border of the Byzantine Empire. The Paulicians were later to be removed to the Western part of the Byzantine Empire, from where they inspired the Bogomil heresy of Bulgaria and the Cathar heresies of the Latin West, although tiny Paulician communities also survived in secluded parts of Armenia, actually into modern times (see [Moos88] p. 435 et seqq.).

[1806] The founder of the Ismaili sect is occasionally identified as Abdullah ibn Maymun, a shadowy figure contemporary with the imam Djafar al-Sadik and the son of an even shadowier Maymun al-Qaddah. These were reputedly adherents of the Syrian Gnostic Bardesanes and, according to some accounts, of Persian or Jewish extraction (see [Lewi40] p. 67 et seqq. and [Hodg55] p. 23). In particular, Abdullah ibn Maymun was accused by hostile sources – the first of which were Ibn Rizam and Akhu Muhsin, both writing in the mid-10th century and the latter himself a descendant of the imam Mohammed ibn Ismail, – of having created an initiatory pseudo-religion, which culminated in nihilism and libertinism and of being the disciple of Abul-Khattab al-Asadi, a notorious *ghulat* revolutionary associated with

by the middle of the 9th century the Ismaili movement becomes visible as a secret politico-religious revolutionary organisation directed from, in turn, Ahwaz in Persia, Basra in Iraq, and Salamiyya in Syria, sending out its zealous missionaries, the *dais,* all over the Moslem world, where they, in such widely scattered areas as Iraq, Persia, Syria, Transoxania, Algeria, the Yemen, and Sind in India, were able to set up sizeable Ismaili *dawas,* 'convocations' or communities. In 899 the movement split into two branches, as the grand master of Salamiyya, Obaidullah, declared himself to be the imam, a claim that some accepted, while others rejected it.

Also in 899, the branch of the movement opposed to Obaidullah's claim, the so-called Carmathians, captured the island of Bahrain, where a kind of Ismaili ideal state, a brave attempt to implement the Kingdom of Heaven on Earth, was established – sustained by the toils of a large number of Negro slaves, whose quantity at one occasion was estimated at 35,000, and a policy of ruthless terror, rapine, and plunder in the adjacent lands.[1807] From Bahrain, the Carmathians terrorised the neighbouring countries, pillaged the Moslem pilgrims on their way to Mecca, and even captured Mecca in 930, where they massacred the pilgrims and stole the black stone away from the Kaba in order to prove the imminent end of Islam, only restoring it in 951, as a substantial ransom had been paid out to them by the Abbasids. In 931, on the basis of certain prophecies, astrological calculations and events, and the crotchet that 1500 years had expired since the times of Zoroaster, a curious, albeit short-lived, attempt to restore the Adamite religion of the Paradise and establish the freedom from the religious laws instituted by the three alleged 'impostors' Moses, Jesus, and Mohammed[1808] by handing over the rule to a young Persian believed to be the expected *Qaim* or *Mahdi,* i.e. the Messiah[1809], foundered, as the Mahdi did not quite live up to the expectations, but started to tyrannise and murder his co-religionists, trying to reinstate Zoroastrianism and the reign of the Magians. The whole episode scandalised and demoralised the Carmathians and caused considerable defections from their ranks and the disclosure of their secret teachings, although they remained in control of Bahrain until 1077-78.

During the first part of the 10th century, the Ismailis, setting out from a base in Algeria, subjugated the entire Western part of North Africa as well as Sicily, thereby laying the foundation for the Fatimid caliphate.[1810] In 910, Obaidullah, who already in 899 had proclaimed himself imam and descendant of Ali, the husband of the prophet's daughter Fatima, basing his claims to the imamate on the alleged existence of a line of "hidden imams", added also the title caliph to his name. The Fatimids conquered Egypt in 969, where they

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Djafar al-Sadik. In some Ismaili documents, the sect founder is identified as Abdullah al-Akbar (the old one), who, according to the contentious pedigree of Fatimid caliphs, was the first of a number of hidden imams as well as the grandson of the eponymous Ismail and the son of Mohammed ibn Ismail. The identity of the two Abdullahs, their rôle in early Ismailism, if any, and what can be known about their views and activities, are moot. See, for example, [Made60] and [Made91], who, following [Lewi40], apparently accepts ibn Maymun as the originator of Ismailism and identical with al-Akbar, whereas [Casa21] p. 127 et seq., assuming Maymun al-Qaddah to be the father of the sect, proposes that he was an adherent of a sect known as 'Fatimids' that abode by the teachings of the heretic Abu Muslim and his daughter Fatima. Some leading scholars of the field pronouncing on the issue lately, such as [Halm91a] p. 163 et seqq., [Halm91b] p. 16 et seqq., [Daft90] p. 109 et seqq., [Daft95] p. 25 et seqq., and [Daft98] p. 36 et seqq., instead follow [Ivan42] p. 127 et seqq. and [Ivan46] in recognising al-Akbar as the most likely originator of the Ismailism and distinct from ibn Maymun, who, according to a theory also proposed by Ivanow, has altogether mistakenly been associated with Ismailism – which, however, is disputed by [Ster83] p. 257 et seqq. (cf. also [Hodg55] p. 30 et seqq.) on what appears to be good grounds.

Whether any particular one of these attempts to bring order in the imbroglio of Ismaili origins is indeed correct or not, the link between early Ismailism and the theosophical speculations of Bardesanes as well as Jewish mysticism remains suggestive. On Bardesanes and the Ismailis, see [Drij66] p. 200 et seqq. and [Ivan46] p. 83 et seqq. (cf. also [Abel65]); on the Kabbalah and early Ismailism, see [Halm78] p. 48 et seqq. et passim. Cf. also [Drij70] and [Lewi40] p. 31 footnote 1. It should be noted that whereas most 19th century Orientalists tended to accept the scandalous reports of anti-Ismailite authors – be they Abbasid, Sunni, or dissenting Ismaili in their bias – at face value, there has since the 1920s been a strong tendency of rehabilitating the Ismailis, – obviously a tendency related to the general rehabilitation of Gnosticism and other 'pariahs' of history – and dismissing as fabrications and legends any unfavourable reports about them. See [Hodg55] p. 22 et seqq, [Daft90] p. 1 et seqq., and [Daft98] p. 14 et seqq.

1807 See [Lewi40] p. 76 et seqq., [Made78b], and [Made96].

1808 See [Mass20]. Cf. also [Corb93] p. 140 on Rhazes as another possible source of this legend, which would later be associated with the emperor Frederick II, whose dealings with the Ismailis remain puzzling, and took on a life of its own in the development of Western thought towards irreligious atheism and materialism. [Grab26] vol. II p. 137 questions the association of Frederick II with the legend, attributing the first Western allusion to it to the renegade monk Thomas Scotus in the 14th century. [Sout62] p. 75 cites Matthew de Acquasparta to show its originally perennialist tenor. On the infamous 18th-century Spinozist tract dealing with this topic, see [BCP96].

1809 On these and some other similar Messianic titles used in Islam, see [Arjo98] p. 249 et seqq. Whereas these titles were appropriated by various military leaders, such as some of the Umayyad, Abbasid, and Fatimid caliphs, the orthodox opposition to "revolutionary Mahdism" held that there would be no other Mahdi than Jesus, the son of Mary.

1810 See [Cana65b], [Halm91b], [Ivan42], and [Olea23].

erected Cairo as capital and a magnificent centre of culture, art, and scholarship. In 1005 the 'mad caliph', al-Hakim, here founded the *Dar al-Hikma,* the famous House of Wisdom, as a university, library, and missionary centre for the Ismaili cause.[1811] For a period, the Fatimids seemed invincible and – at least formally – controlled a huge territory, which extended from the Atlantic to the Indian Ocean, but rather soon their power began to decline and was finally reduced to Egypt. Various secessions due to dynastic controversies damaged their image and lead to the formation of new Ismaili sects, such as the Druzes, which was a splinter-group formed by some of al-Hakim's most devout adherents after his mysterious disappearance in 1021, still thriving in parts of Lebanon and Syria, and the two branches of the Nizaris and Mustalis in 1094-95, as Nizar, the heir to the throne, had been ousted by his younger brother al-Mustali and then murdered, at the behest of the powerful and Machiavellian vizier al-Afdal. By the same token, the Yemeni Mustalians were somewhat later estranged from the Fatimids by another dynastic scandal and formed the Tayyibi sect. In 1171, Saladin put an end to the now rather anaemic Fatimid caliphate, which had passed its acme long since, and restored Egypt to orthodox Sunni Islam.

In the meantime, an energetic convert to the Ismaili sake and stout adherent of Nizar, the *dai* Hassan Sabah, who in 1090 had succeeded in capturing the stronghold of Alamut in a godforsaken part of Northern Persia, established the Ismaili sect usually referred to as the Assassins.[1812] From Alamut he led a network of bold Ismaili revolutionaries, who successively secured a fair number of citadels tucked away in mountainous, secluded regions of Iran and Syria. From these he and his successors embarked on an unprecedented programme of political terrorism, sending out the much-feared *fidais,* the "assassins" proper, who with their daggers stabbed a sizeable number of important persons, who stood in the way of Hassan and the Nizari Ismailis.[1813] In Syria and Lebanon, the Assassins had gained prominence amongst the Ismailis at about the time of the First Crusade and they later got a formidable leader in the *dai* Sinan, also known as Rashid al-Din.

In this area, they were to have extensive and, at times, puzzling dealings with the Christians crusaders, with whom they would both strike alliances and cross swords.[1814] For example, in 1173, during negotiations with Amalric, the king of Jerusalem, Sinan offered to convert the Assassins to Christianity[1815], but the treaty was never concluded because of a murder of an Ismaili legate committed by a Knight Templar – i.e. a member of the possibly heterodox monastic order, which often has been suspected for connivance with the Assassins. In 1192 Conrad of Montferrat, who had just been elected king of Jerusalem in preference to Henry of Champagne, Richard the Lionhearted's nephew and candidate for this glorious office, was murdered by two Assassins disguised as Christian monks. As torture was applied, it transpired that the murder had been commissioned by Richard, although the trustworthiness of this piece of information has been doubted, as in such circumstances the fidais were in the habit of giving misleading information, which, if possible, would compromise their own enemies.[1816] There are also rumours about Christian princes, who either are reported to have contracted Assassins or to have been plotted against by them, and Richard the Lionhearted was even

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1811 See [Sour65] and [Halm97] p. 71 et seqq.

1812 Besides the already mentioned studies of Ismailism in general, see [Hodg55], [Lewi67], [Fran69], and [Frèr73]. On the "assassin legend", see [Daft95], whose author has produced some of the most erudite and useful works on Ismailism, their rather overtly apologetic drift notwithstanding. Cf. also [Hodg55] p. 133 et seqq.

1813 See [Lewi67] p. 125 et seqq. for a discussion of the historical antecedents of political murder and the links between this phenomenon and religiously motivated ritual murder and human sacrifice as practised by, for example, some extremist gnostic-antinomian Shiite sects in the eight-century Iraq that also provided the cradle of Ismailism. Cf. also [Davi81] p. 84 et seqq. and [Fran69] p. 182 et seqq. on the Thugs of India, the murderous Kali worshippers, believed to have been the descendants of the Persian Sagartii. The fact that the Mafia, which is held by some scholars to have its roots back in the Middle Ages, emerged on Sicily, an island that was under Fatimid suzerainty for almost two centuries, is suggestive, although I do not know of any scholarly examination of the possibility of a relationship between it and the secret Ismaili societies. Additionally, it has been observed that political murders seem to become more frequent in the Latin West, as the contacts with the Moslem world grew during the crusades, be it that this is to be understood as a consequence of the example set by the Assassins or as an unrelated European development of political cynicism.

1814 See [Lewi69a] and [Daft95] p. 49 et seqq. There will also have been interactions between the crusaders and various other sects of the Near East. For example, [Gues87] p. 52 mentions that some Yezidi tribesmen, during negotiations with Christian missionaries in 1668, claimed that there was a tradition amongst them that they were descended from crusaders who had fled into the mountains after the fall of Antioch.

1815 [Daft90] p. 398 rejects this piece of information with characteristic aplomb.

1816 See [Lewi69a] p. 125 et seq. Some sources make Saladin or Sinan, or both, the instigators of the murder.

accused of training assassins himself.[1817] Furthermore, in 1227 the emperor Frederick II sent gifts worth 80000 dinars to the Syrian Nizari chief destined for Alamut and was rumoured to have taken advantage of the services of the Assassins to get rid of Duke Ludwig of Bavaria.[1818] Throughout the crusades, both the Hospitallers and the Templars had extensive dealings with the Assassins, involving both the exaction of tributes and the forging of alliances.[1819] And when in 1238 the military menace from the Mongols began to loom large, the Assassins – oddly, in co-operation with the Abbasid caliph – sent a delegation to the kings of France and England, Louis IX and Henry III, asking for help, albeit in vain.

In default of such help, the Persian Nizaris, lead by the defeatist imam Khurshah, were shattered by the Mongols, who in 1256 destroyed Alamut together with its famous library, two years before their notorious capture and depredation of Baghdad, and then attempted to suppress the sect altogether by massacring its members wherever they were found. In the 1270s, the Mamluk Sultan Baibar gained control over the Assassin strongholds in Syria, thereby putting an ultimate end to the political significance of the sect, although he and his successors tolerated it, also taking occasional advantage of the poniards of the fidais for the elimination of their own enemies. Ismailism never really recuperated from these setbacks and has remained a minor branch of Islam ever since, although the sect was able to survive in secluded or distant areas and some of its members went underground, disguising themselves, in Sufi orders.

So what were the Ismaili teachings? Firstly, these were never organised into a fixed doctrinal system and thus were prone to change considerably over time – in fact the imam, whose infallibility was never questioned by the Ismailis, could at any time alter the doctrines, as also happened a few times. During its first expansive period, ranging from the mid-9th to the late 11th century, the Ismaili movement attracted many leading intellectuals, but from about 1100 its allure steadily declined, the Nizari period being marked by the growing isolation of the sect. Although Ismaili thought is usually characterised as a kind of Moslem Gnosticism, its more specific characterisation is not easy. One may discern Manichaean, Bardesanite, Neoplatonic, Neoaristotelian, Neopythagorean, Hermetic, Jewish, Kabbalistic, and Christian traits in the peculiar mixture of theosophical emanationist cosmology, historiosophical Messianism, utopian religio-political absolutism, batinist exegesis and perennialism, antinomian morality, and esoteric occultism that is Ismailism, but, for all these precursors and backdrops, its exact intellectual roots still largely remain clouded in obscurity.

Fundamental to the Ismaili approach to religion is the division between *zahir* and *batin,* where *zahir* represents the exoteric aspect of religion, the *tanzil,* or outer revelation, which changes with different prophets, whereas *batin* stands for the unchanging esoteric aspect, the *haqiqa,* "inner reality" or "inner truth" of religion and existence, at which one arrives through *tawil,* spiritual-allegorical exegesis, for example on the basis of cabalistic letter and number symbolism. Consequently, the Ismailis called their own religion *din al-haqq,* the religion of truth, and themselves *ahl al-haqq,* the people of truth.[1820] There is in Ismailism a strong tendency to play down the importance of the *zahir* together with the moral law, the *sharia,* which was said to be for the *amm,* the ignorant mass, while it was not incumbent on the *khass,* the élite initiated into the Ismaili esotericism. As in Gnosticism, this tendency occasionally led to eruptions of *anomie,* which, however, may be a danger inherent in any espousal of the "law of freedom" of non-casuistic ethics, rather than an intended or desired effect.

The Ismailis were organised as a strictly hierarchic secret society, stratified into religious ranks, *hudud*, and the sectarians advanced by initiations, *balagh,* through a number of stages*,* variously given as seven or nine.[1821]

[1817] See [Nowe47], [Hodg55] p. 138 and p. 208.

[1818] [Nowe47] p. 511. See also [Kant28] vol. I p. 178 et seqq.

[1819] See [Daft90] p. 420 et seq. and [Nowe47] p. 504 et seqq.

[1820] See [Hodg60]. According to [Corb93] p. 245, Averroës' doctrine of the "double truth", which was bound to make such a fateful imprint on Western thought, is a reformulation of the *zahir-batin* distinction. The roots of this distinction are to be found in the distinction *esoteric-exoteric* prominent in both ancient religion and philosophy from very early times. As for the spiritual-allegorical exegesis, Theagenes of Rhegium read Homer allegorically already in the 6th century B.C. and the Stoics made extensive use of allegorical interpretation of Homer and other sacred texts, as did many others, including Philo and the Neoplatonists. Amongst Jews, Christians, and Moslems alike, as indeed in most scriptural religions, such methods of interpretation were widely used early, albeit not always uncontroversial. See [Lamb89], [Luba59], and [Corb93] p. 1 et seqq.

[1821] See [Cana65a]. Cf. also [Casa21].

The rank and file of the sect was usually referred to as *rafiq,* comrades. The nature of the secret teachings provided by the initiatory system is disputed, as our knowledge of it is largely derived from the hostile polemics of Sunni and Imami Shiite authors. In his lively and readable book on the Assassins, *History of the Order of the Assassins,* Enno Franzius summarises the picture that appears from these sources in this colourful way:[1822]

> *In the proselytizing process an Ismaili dai would generally begin by infusing doubt into the mind of the intended convert in order to demonstrate the need for an authoritative teacher. Thus, he might ask why God had devoted six days to the creation of the world, whether He could not have done it in an hour, what were the demons and what was their power, what were the torments of Hell, or why the first chapter of the Koran had seven verses. From these Koranic subjects he might proceed to more mundane matters and inquire why man has ten toes, ten fingers, and seven orifices in his head.*
>
> *If the anticipated initiate requested answers to these questions, he would be apprised that the sublime verities of God's true religion were too priceless to be revealed to those who might maltreat it. Consequently, before disclosing God's mysteries, the dai would ask him to swear not to betray him or other Ismailis, to be truthful with him, not to join the foes of the Ismailis, and to continue the outward observance of Sunnite rites. If the prospective proselyte gave the pledge, he would be asked for an offering.*
>
> *If this was also forthcoming, he was judged worthy to enter Ismaili ranks and would be admitted to the first degree, that is, he accepted the principle that the revelations of the Koran had a superior esoteric meaning, to understand which he required the help of a divinely authorized interpreter.*
>
> *He entered the second degree when he was convinced of the error of Sunnite teachings and of the need to replace private judgment by an authoritative guide, that is, the Imam or his representative. The great majority of converts did not go beyond the second degree.*
>
> *The third degree acquainted the disciple with the sacred significance of the number seven, informed him of the first seven Ismaili Imams and the esoteric names by which their intercession might be invoked. They were to be revered both for themselves and their sacred number, which was proof that Ismailism was the true religion.*
>
> *In the fourth degree the postulant learned that God had sent seven prophets incarnating* Reason *to reveal His will. Each prophet had an associate (an Asas or Imam) to interpret his revelations. The prophet was thus the recipient of divine inspiration, the Asas or Imam his heir, executor, and interpreter who opened a cycle of seven Imams. The prophet Adam had Seth as Asas, Noah had Shem, Abraham had Ismail, Moses had Aaron and later Joshua, Jesus had Peter, Muhammad had Ali, and finally the seventh Prophet, Ismail, or his son Muhammad had Abdullah ibn Maimun al-Kaddah (the Oculist), a shadowy but gifted Ismaili organizer of the late eighth or ninth century. The acceptance of a prophet after Muhammad, who had declared himself to be the final Prophet, abscinded the initiate from Sunnism.*
>
> *Indeed, the fifth degree rejected revealed religion and the observances based on the literal interpretation of the Koran, which, it was asserted, were for the ignorant masses, who could not understand Ismaili principles. The candidate's mathematical and numerological knowledge was deepened and its magical value stressed.*
>
> *Only if the dai was convinced of the aspirant's discretion would he proceed to the sixth degree, for it instructed him to abandon overt Muslim observances, such as prayer, fasting, and pilgrimage, or to perform them only if expedience required. Such ordinances, the initiate was informed, had been promulgated by the prophets only to subordinate the masses to law and order. The dai then expounded the teachings of Plato, Aristotle, and Pythagoras and dwelt on the superiority of Greek philosophy over revealed religion. He urged his pupil to believe only what his reason accepted. This degree entitled the convert to become a dai.*

1822 [Fran69] p. 26 et seqq. Cf. also [Lewi67] p. 48 et seq., [Brow1909] p. 410 et seqq. and [Olea23] p. 21 et seqq. Franzius probably based his pithy exposition of the secret doctrine of the Ismailis on the translation of a portion of al-Maqrizi's *Khitat* found in [Casa21], but deviates from it on various mostly minor points. The interested reader should peruse the text in its entirety in [Casa21].

Few attained the seventh degree, in which Aristotle's theory of the eternity of matter was taught. Creation was not the fabrication of the non-existent but the introduction of movement, thus producing time and change.

Two further degrees were added to the mystic seven. The eighth taught that there are two Principles, the nameless First Cause and the Second Cause. The latter had been generated by a thought of the former, as the spoken word proceeds from the thought of a speaker. The Second Cause acts as intermediary between unknowable God and Man.

For the ninth degree Ismaili leaders studied the Greek philosophers' treatment of the soul, the heavens, and the intelligence. By then they had abandoned all faith and submitted to no authority other than their own reason.

Although we should keep in mind that the above account may be somewhat tinted by the biases and interests of the Sunni and Imami heresiologists, who are the primary sources of it, and that some present-day scholars would deny its trustworthiness altogether[1823], denouncing its modern adherents as touched by a 19th century pre-occupation with conspiracies now supposedly discredited or at least out of vogue in academic circles[1824], it seems likely that the main lineaments are valid, being by and large confirmed both by what we

[1823] Important discussions of the matter including translations of the fragments are found in [Casa21], [Sacy1838] vol. I p. LXX et seqq. and [Ster83] p. 56 et seqq. Cf. also [Lewi40] p. 90 et seqq. The *Kitab al-siyasa (Book of Methodology)* – or *Kitab al-balagh (Book of Initiation),* possibly being but a different title for the same book – cited by anti-Ismaili and anti-Fatimid polemicists is dismissed by [Ster83] p. 56 et seqq., [Daft98] p. 11, and [Halm91b] p. 25 (cf. also [Made96] p. 43 et seqq.) as "anti-Ism□ʿ□l□ travesties", "malevolent forgery", and "böswillige Fälschung". The posthumously published, possibly unfinished article [Ster83] p. 56 et seqq., which is often cited as proving this conclusion, in fact only collects some of the fragments of this book found in the writings of a few anti-Ismaili controversialists and dogmatically asserts that it is a libellous travesty to be compared with the *Protocols of the Wise Men of Zion,* without citing any evidence whatsoever in support for this bold supposition. In fact, Stern, both in this article and elsewhere in his book, acknowledges that, despite the polemical varnish, there is also a strong factual component to the *Book of Methodology*. Although some will be tempted to speculate that it was put together by Abbasid, Sunni, or Imami propagandists, this may be an *a priori* dubious projection of modern-style methods of psychological warfare and disinformation onto the 10th century Abbasid caliphate. On closer scrutiny, most of the arguments adduced against its authenticity actually appear to be of rather dubious merit.

Firstly, the fact that these writings are cited almost exclusively by anti-Ismaili sources has little bearing on their genuineness, as the secrecy and potentially invidious nature of their contents make this exactly what one would expect, whether they are genuine or not – after all, secret books of initiatory arcana will only remain so, if their existence and contents are not divulged to the uninitiated by references and citations in writings of a less secretive character and, whenever something hereof does leak out, this is disavowed or hushed up by those in the know. Secondly, the analogy with modern-time denigration campaigns and forgeries, such as the *Protocols of the Wise Men of Zion,* may be specious and can be countered by the as obvious – and possibly as specious – analogies between the Ismaili secret societies and phenomenologically similar bodies and structures, as for example, the secret societies so powerful in many 'primitive' cultures, modern terrorist organisations, or curious religious sects and secret political societies, such as Adam Weishaupt's Bavarian Illuminati or L. Ron Hubbard's Church of Scientology. Thirdly and most importantly, when due account has been taken of the distortions inflicted by the polemical stance of the authors that cite these writings – for example the accusations of atheism and nihilism may be a foregone, albeit comprehensible, conclusion on their account – the contents of them, fragmentarily known as they are, seem to sort well with what we know for sure about Ismaili philosophy, the Ismaili religio-political agendas, and the Ismaili revolutionary activities and Messianic-utopian experiments. In particular, the much fuller and less polemically coloured account given by al-Maqrizi (translated in [Casa21]), which is glossed over by Stern, who instead more or less equates al-Nuwayri's obviously polemically belaboured account with the contents of *Kitab al-siyasa* itself, in fact excellently sums up Ismaili doctrine as known from reliable Ismaili sources. Fourthly, the strength of the best witnesses that describe the initiatory system, such as Akhu Muhsin, who, himself being a descendant of Mohammed ibn Ismail, arguably ought to be well-informed about the identity and doings of his own relatives and whose general accuracy is recognised by Stern himself (see [Ster83] p. XXI), or al-Ghazzali, one of the most incisive and learned Moslem scholars and intellectuals of all times, is often passed over in silence by those anxious to clear the Ismailis of the 'black legend', which, apart from the question of the truthfulness of these accounts, admittedly has caused much deplorable suffering to the Ismaili communities throughout the ages and still is apt to do so in regions where the political and religious situation makes their predicament precarious. Although the picture given by the Sunni polemicists and some 19th century scholars seems to have been painted in excessively dark colours, one must also ask if the tendency of white-washing has not gone too far with some modern researchers. After all there is much about the Ismailis that lends itself to a rather sinister interpretation, and at least some of their politico-religious leaders seem to have evinced a remarkable degree of cynicism.

[1824] On the history of conspiracy theory, see [Robe74], [Roga92], [Epst66], [Pipe97], [Camp97b], [Cohn70b], [Ludz79], [Hamm80], [GM87], [Kalt87], [CN01], [Dard98], [PL94], [Lema98], [Rous98], [Droz61], [Wils89a], [Hofs64], [Webb76] p. 213 et seqq., and [Part87] p. 89 et seqq., of whom the latter also elaborates on the associations to "the Assassin legend", vigorously oppugned in [Daft95]. As can be gathered from the rather high-strung, not to say nervous, occasionally pompous, and often unabashedly tendentious tone of voice in most of the referenced works, the ideological dimension of these conspiratorial issues – and their association with crank lore, anti-Semitism,

and various absurd *Drahtzieherttheorien* – tend to create a very stifling air about them, making them terrain where scholars fear to thread – even to make light of them – or do so only with great trepidation and numerous abjuring protestations and lengthy psychologising innuendoes and aspersions. Rather ironically, all this scholarly piaffing, certainly also fomented by the conspiratorial-paranoid climate prevalent in many academic milieux and the widespread academic complicity in and sympathies for the very real totalitarian conspiracies that threatened to enslave the world during the larger part of the previous century (see, for example, [Wein79], [WV99], [KHA98], [KHF95], [Drum87], and [Cham87]), is liable to engender the semblance of yet another, even grander conspiracy theory, in which the conspiratologists take on the rôle of the conspirators and the demonic originators of all the evils of history and the scholars themselves appear as the heroic meta-conspiratologists who reveal the insidious plot against mankind! There is a very disturbing tendency in these arrogant, usually openly leftist scholarly outpourings against the musings of the mostly non-academic, or at least academically marginalised, conspiracy theoreticians to shift the attention away from the *modernist, Enlightenment,* and largely *academic* origins of the appalling totalitarian murderousness of the last hundred years – in the modern secularism and nihilism, in the socialist class and race hatred, in the Romantic-Hegelian cult of the nation and the state, in the virulent anti-Christian neo-paganism, neo-Gnosticism, and philosophical atheism, and in the 'scientific' Darwinist and sociobiological doctrines cherished by these pulpiteers of academic self-righteousness, so bitterly resentful of the *Semitic* Jewish-Christian religions – and to put the blame on – indeed often ridiculous, but at times thought-provoking and intriguing – conspiracy theories or even an imaginary Christian tradition of anti-Semitic conspiratology. How a religion of which the founder and early apostles and disciples all were Jews and of which the foremost command was that man should love his neighbour, whether Jew or Greek, can be made out to be anti-Semitic defies rational explanation – except if we are to judge Christianity by the behaviour of trespassers and rebels against its very essence.

Modern conspiracy theory is often mistakenly made out to be the exclusive arena of the "far right", although a plethora of both apolitical and political, left and right wing variants exist, and it in fact primarily originated in the rhetoric of the Enlightenment philosophers against the "conspiracy of tyrants and priests" and the incidental campaign against the Jesuits (cf. [Aget84] p. 279 et seqq.), in essence being an immanentisation of Christian eschatological ideas, where the schemes of the Devil, Antichrist, and the demons have been replaced by the ruses of innerworldly agents. Very soon having been turned against its own 'enlightened' originators, who themselves were now accused of plotting against the throne, the altar, and the entire societal order, this revised conspiratology gained considerable ground during the attempts to understand the French Revolution, as an alternative to theories of it as the upshot of the more or less random unfolding of events, mass hysteria, some kind of social mechanics, unfathomably complex forces beyond man's understanding, or divine punishment. Although some of the seminal ideas of this theory were suggested in Abbé Le Franc's *Voile levé pur le curieeux,* published already in 1791, and further refined in his *Conjuration contre la religion catholique, et les souverains* [LeFr1792] (cf. [Défo65] and [Robe71]), its most famous exponent was to be the erudite Abbé Barruel, in whose account of the revolution [Barr73], *Mémoires pour servir a l'histoire du Jacobinisme,* first published in 1797-98 and soon translated into a large number of languages (including Swedish), the main culprits identified were the free-thinking, profoundly anti-Christian *philosophes,* the anti-Christian and anti-royalist Freemasons, and Adam Weishaupt's anti-religious and anarchistic *Illuminati,* who, according to Barruel, had managed to infiltrate and gain control over important portions of French masonry (on the recent substantiation of this much-scolded suggestion through the recovery of the contents of the leading illuminatus Bode's so-called 'Schweden-Kiste', see Schüttler's fascinating foreword to [Bode94]). Although Barruel's work has become a major bugbear to certain groups, repeatedly being denounced because of its supposedly naïve pan-conspiratology and various other alleged idiosyncrasies and failings, its account was very widely – albeit not quite universally (see e.g. [Moun1801] and [Derm46] p. 83 et seqq.) – accepted by well-informed and intelligent contemporaries, which fact should give the modern historian inclined to dismiss it out of hand pause. In actuality, Barruel, as seen by [Hofm93], provides a both profound and probing analysis of the Enlightenment, modernity, the French Revolution, and the spiritual forces behind them, drawing attention to, for example, how the cynical manipulation of *la volonté général,* the public opinion – or rather "published opinion", the illusion of public opinion – so eagerly indulged in by the so-called *philosophes,* who in truth are not philosophers at all, but self-serving sophists, becomes the prime characteristic of the anti-theocratic society they had set out to bring about, how the language and the meaning of words are manipulated in such a society so as to serve all kinds of dubious purposes, how the pompous declarations and empty intellectual abstractions of the *philosophes* actually spring from pride, vanity, and a craving for power, and many other astute observations still of great relevance. A biography of Barruel is provided in [Riqu89]. Another very influential, but more compendious work of the same tendency was John Robison's *Proofs of a Conspiracy* [Robi67], in which the Edinburgh professor of mathematics sets out to unveil the continued seditious activity of the atheistic-materialistic Bavarian Illuminati also after their disbandment in 1785, yet another Johann August Starck's *Triumph der Philosophie* [Star1834], which attempted to supplement and correct Barruel's and Robinson's accounts on various counts. Partly on the basis of the fanciful Masonic legends (see [Mack96]), of Catholic-Protestant polemics (see [Barb00] p. 212 et seqq.), of the still vigorous *prisca theologia* speculations, and of the suggestions made by leading radicals and historical revisionists, such as Gottfried Arnold, Voltaire, Condorcet (see [Cond66] p. 166 et seqq.), Thomas Paine (see [Bill80] p. 103), and the authors of some articles in the *Encyclopédie* (see [Gass99] p. 231), a theory of a great chain of revolutionary-anarchistic secret societies – including the Freemasons, the Templars, various heretics, the Cathars, the Assassins, the ancient Manichaeans and Gnostics, and, optionally, some pagan mystery cult (Dionysus, Eleusis, Isis, Mithras, etc.), the Essenes, the Pythagoreans, the Sophists, or even the Druids – was also worked out by Friedrich Nicolai, Cadet Gassicourt, Abbé Barruel, and others (see [Part87] p. 128 et seqq., [Gass99], and [Barr73] vol. I p. 456 et seqq.).

The Masonic "Templar myth", deriving Freemasonry from the medieval Templars, who, albeit suppressed in 1307 by Philippe le Bel, managed, according to this legend, to survive in Scotland under the cover of Masonry, surfaced in the 1750s – although it might have been alluded to already in the famous speech made by Chevalier Ramsay to an assembly of French Masons in 1736 – through the enigmatic founder of the German 'strict observance' of Masonry, Karl Gotthelf von Hund, and was further embroidered by the adventurers Philipp Samuel Rosa and Georg Friedrich von Johnson a Fünen. Von Hund claimed to have been initiated in 1743 in Paris into the Order of the Temple, which, if not just von Hund's brainchild, as has occasionally been claimed, may have been some kind of secret organisation for the support of the Scottish Stuart pretenders and/or the creation of a utopian state in North America, and to have in his possession a mysterious "red book" – now apparently lost – that described this order and its organisation, intriguingly believed to be headed by the elusive *S. I.,* the *superiores incogniti.* See [Schü96], [Schü97], [LeFo70], [Kerv99], [Schu02], [Fric73] p. 219 et seqq., [Wait] vol. II p. 217 et seqq., [Robe74] p. 121 et seqq., [Part87] p. 103 et seqq., and [Corb86] p. 263 et seqq. The Assassin-Templar connection, which had been suggested already by [Gass99] p. 31 et seqq. in the 1790s, was elaborated on by the Austrian Orientalist von Hammer-

know from Ismaili sources and by the history of Ismailism and the general drift of the interests of its leading intellectuals. Considering the politico-religious climate prevalent at its time of origin, the Ismaili system and doctrine as outlined above also seem to be quite a natural development, as reflective men tried to make sense of the apparent ephemerality of the religious revelations that successively swept the Near East, attempting to find the common core, the "philosophia perennis" behind the plurality of contending truths.

As can be seen from the above account, a cyclical historiosophy, which obviously is a generalisation of Mohammed's own understanding of himself as the last in a chain of prophets – and ultimately of the Christian idea of different covenants –, plays a central rôle in Ismailism.[1825] According to this scheme, there have from Adam to Mohammed been six *natiqs,* prophets or speakers, each giving to mankind a new religious law and each supplemented by a *samit,* a silent man or imam, also referred to as a *wasi,* executor, or *asas,* fundament, who batinistically explains to the elect the inner meaning of the revelation.[1826] Each prophet is followed by seven imams, of which the last one will be the next prophet and repeal the religious law of the previous era in order to be able to establish a new one. It seems that the Ismailis originally believed that their last imam, Mohammed ibn Ismail, had not died at all, but only disappeared mysteriously and that he would soon come back as the seventh and last *natiq,* but also as *Qaim,* Resurrector, and *Mahdi,* Messiah. As Lord of the world, the *Qaim-Mahdi* would then judge mankind and, having abolished Islam and all other *zahir* religions and abrogated the sharia and the various other religious laws, restore the original lawless paradisiacal state through the *qiyama,* the Resurrection, by which the *batin* religion, to which currently only the élite of the Ismailis were privy, was to be unveiled to all and established as the common religion of mankind. This hierohistorical framework was disrupted by the Fatimid claims to the imamate, leading to the formulation of a spiritual reinterpretation of the rôle of Mohammed ibn Ismail as Qaim and the postulation of "hidden imams", who presided during periods of *satr,* occultation, though we cannot here go into the details of these doctrinal developments, let alone of those that followed in the wake of the further proliferation of Ismaili sects.

The Messianic expectations, which also contributed greatly to the revolutionary and military fervour of the Ismaili movement, were at times escalated to great heights.[1827] Already Obaidullah had laid claim to the title *al-Mahdi,* and in 931 the *qiyama* was believed to be imminent amongst the Carmathians, who, as already mentioned, hailed a Persian impostor as *Mahdi* and *Qaim.* Likewise, on August 8 of 1164, in the middle of the Ramadan, Hassan II, the Lord of Alamut, proclaimed the *qiyama,* thereby abrogating Islam, the sharia, and the hierarchical esotericism of the Nizaris and making the secret Nizari lore public, including the conception of heaven and hell as spiritual states and an allegorical interpretation of the Resurrection as the act of seeing God

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Purgstall, who, in his *Die Geschichte der Assassinen,* made the Assassins the prototype for various latter-day secret societies, including the Templars, Freemasons, and Jesuits, of all of which he himself strongly disapproved (see [Hamm1818a] p. 336 et seqq.). He also wrote extensively on the guilt of the Templars, whom he, partly on the basis of odd archaeological findings, which, at least partly, appear to be the outcome of some kind of curious hoax (cf. [Part87] p. 140), connected with the ancient Gnostics, in particular the Ophites, through the Assassins (see [Hamm1818b-c] and [Hamm1855]). Such grand conspiratorial schemes have been entirely out of vogue amongst scholars for long and are presently mentioned in the scholarly literature only to be cavilled at or ridiculed, whereas the mirror picture of a Gnostic tradition construed as a positive alternative to mainstream Western Christianity has oddly gained widespread popularity amongst academics apparently disaffected with the current predicament of the West (see, for example, [Schu02]). Nevertheless, the last 50 years or so of research on the intellectual traditions of the West has made it increasingly clear that the sap of the Western Faustian spirit of politico-scientific utopianism has flowed from a mighty underground tradition of Gnosticism, Hermeticism, Neoplatonism, Cabalism, occult pursuits, and suchlike, which can ultimately be traced back to late Antiquity, thereby substantiating the basic intuitions of Abbé Barruel and von Hammer-Purgstall – which does not, of course, imply that all of their historical interpretations and constructions have weathered well or that the category of "conspiracy" is the most adequate in dealing with this tradition. For one thing, the evidence for a connection between the Templars and early Freemasonry remains doubtful, and also the question of the guilt of the Templars continues to be as contentious as ever. See also footnote 1951 on p. 418 below.

[1825] See [Corb93] p. 86 et seqq. and [Corb83] p. 1 et seqq.

[1826] In order to clarify the general thrust of the Moslem sects, Orientalists often make a distinction between 1) the *Mimiyya,* i.e. those, who emphasise the exoteric *zahir* aspect of the revelation as proclaimed by the prophet himself, symbolised by the *mim,* the first letter of Mohammed, 2) the *Ayniyya,* i.e. those, who instead exalt the imam's esoteric *batin* exegesis, represented by *ayn,* the first letter of Ali, and 3) those, who pay allegiance to the *sin,* the first letter of Salman Farisi, a Persian shoemaker, who belonged to Mohammed's household and was held to be the *bab,* or Gate, through which men came to the truth/Mohammed. See [Corb93] p. 132.

[1827] The important study of Islamic apocalypticism [Arjo98] shows how early Islam was rife with Messianic expectations, which were, for example, attached both to the Abbasid and Fatimid caliphs, and how these were transformed over time through the "containment" of the apocalyptic charisma and the revolutionary impetus in the ruling dynasties of the caliphates. Cf. also [Cook01].

in the imam.[1828] Although the divinity of the imam was not universally acknowledged amongst the Ismailis, he was generally held to be infallible and, thus, exercised absolute authority over his herd – a docetic imamology lending support to these claims was also cultivated by the Ismaili theologians.[1829] By generalising a form of Gnostic Christology, the Ismailis, it appears, arrived at their peculiar notion of a hereditary office of absolute, infallible religious – and during long spells also political – authority, which was by its very nature bound to lead to curious alterations and reversions of their doctrines. In fact, the early Ismailis' devotion to the imam and their emphasis on his absolute authority as a spiritual guide was their single most noticeable feature in the eyes of many contemporary observers.[1830] Notably, the Ismailis opposed their principle of the imam's spiritual authority to the use of reason as the ultimate criterion in religious-philosophical questions, as advocated by, for example, the Mutazilite theologians and a few rationalist philosophers, such as Rhazes.[1831]

From Franzius' account of the Ismaili secret doctrine quoted above one can get the impression that the last stage on the Ismaili ladder of initiation implied a kind of modernist atheistic-nihilistic outlook, inspired by the rationalism nowadays on rather dubious grounds generally attributed to Greek philosophy. To the Arabs, Greek philosophy was, however, a deeply religious-spiritual affair, more or less synonymous to Neoplatonism. In the at the time common historiography of Greek philosophy, a succession of five great philosophers was outlined, viz. Empedocles, Pythagoras, Socrates, Plato, and Aristotle, who, largely due to a corpus of anecdotal stories and pseudepigraphical writings and sayings, were all believed to have embraced a kind of Neoplatonist 'philosophia perennis'. Within this general Neoplatonic framework, two schools of philosophy were often distinguished, one Hermetic-Pythagorean of Illuminism *(ishraqiyun)* and another Aristotelian of Peripateticism *(mashshaun)*.[1832]

Recent scholarship has put together a picture of a philosophical development within the Ismaili sect from Gnosticism towards Neoplatonism, although the Gnostic element remained vigorous also in the later phase.[1833] In the original Gnostic creation myth of the Ismailis, the starting-point was the divine imperative *kun,* "let there be", which through a piece of Kabbalistic letter manipulation gave rise to the two original principles, the female *Kuni* (the feminine form of "let there be") and the male *Qadar* ("omnipotence"). The seven letters that make up these two words are construed as archetypal for the seven prophets Adam, Noah, Abraham, Moses, Jesus, Mohammed, and Ismail (or Mohammed ibn Ismail) and their respective revelations. Through the hubris of *Kuni,* who believed that she herself was God, the world came into being, as God created it in order to humble her. In this process, three spiritual beings called *djadd, fath,* and *khayal* appeared, which were identified with the three archangels Djibrail, Mikail, and Israfil, who together with Kuni and Qadar made up the pentad of the Ismaili pleroma. There are rather obvious parallels between the alphabetic mysticism of the Kuni-Qadar scheme and similar ideas in the Jewish Kabbalah and amongst some Gnostics, such as Marc of Memphis. The mystical science of letters, *djafr,* attributed to the imam Djafar al-Sadik, was to play an important rôle in Moslem mysticism and occultism, where it is prominent in the writings of, for example, Jabir, Avicenna, and Ibn al-Arabi.[1834]

During the 10th and 11th centuries, the dai al-Nasafi, the philosophers al-Sijistani and al-Kirmani, the famous poet (and dai) Nasir-i Khusraw, and others reshaped the Ismaili cosmology towards Neoplatonic emanationism, apparently inspired by the Neoplatonist philosophy developed by al-Kindi, al-Farabi, and Avicenna. In this new cosmology, God appears as an absolutely transcendental abyss, beyond both being and

[1828] The sharia was later reinstated by one of Hassan's successors and then relaxed again. Characteristically, these doctrinal tergiversations lead to new "spiritual" interpretations of alternating periods of *satr* (occultation) and *qiyama* (resurrection). See [Hodg55] p. 141 et seqq., [Buck84], [Jamb90], and [Arjo98] p. 273 et seqq.

[1829] See [Maka67], [Corb83] p. 103 et seqq., and [Corb93] p. 90 et seqq.

[1830] See, for example, [Nasr92] p. 33.

[1831] See [Corb93] p. 137 et seqq.

[1832] See [Nasr92] p. 32 and [Corb93] p. 153. On Aristotelianism in the Islamic world, see [Pete68]. On how the fundamental ideas of the Neoplatonism of Late Antiquity and the Moslem philosophers were shaped, see [Merl63].

[1833] See [Halm78] and [Halm96].

[1834] See [Corb93] p. 75 et seq. and p. 144 et seqq. Cf. also [Schu02] p. 23 et seqq. One may also ask what relation, if any, St. Paul's discussions of the *στοιχε□α τοῦ κόσμου (stoicheia tou kosmou),* "the rudiments of the world", which phrase may also be rendered as the "letters" or "sounds of the world", has to this kind of alphabetical mysticism.

comprehension in his aloofness.[1835] Through His inscrutable volition or decree, *Amr,* the Universal Intellect, *Akl,* which is identified with the Allah of the Koran and the God man worships, comes into being, and from it the Universal Soul, *Nafs,* emanates as the first emanation, from which, in turn, the seven celestial spheres with their respective intellects, brought into motion by the World Soul, then cascade.[1836] Of these, the lowest, the *Active Intellect,* usually equated with the Holy Spirit or the angel Gabriel, rules over the sublunary world. The revolution of the spheres makes the qualities heat, cold, dryness, and humidity mix and form the elements, from which plants, animals, and humans with their vegetative, sensitive, and rational souls develop in an almost evolutionary manner. In a typically Hermetic-occult manner, a web of innumerable correspondences and sympathies is believed to hold together the different levels of being in the cosmos, the microcosm and the macrocosm.

Although Ismailism usually is characterised as a kind of Moslem Gnosticism and doctrinal parallels to various Gnostic sects, such as the Ophites, Valentinians, and Manichaeans, can be pointed out, it should, however, be noted that Ismaili Gnosticism also departs from ancient Gnosticism in some important ways and, in fact, seems as close to Hermeticism, Neoplatonism, and the Kabbalah as it does to Gnosticism proper. Notably, it does not, in spite of its spells of antinomian derailments, share in the usual Gnostic anticosmism and antisomatism, but rather, both comporting with and, by virtue of its intense Messianism, escalating the general thisworldly, political-utopian thrust of Islam, tends to divert the religious energy from asceticism and mystical pursuits towards innerworldly activities, in particular of a revolutionary-utopian and occult-scientific nature, in ways that strikingly prefigure what was to follow in Western Europe in later times. For one thing, the transformation of the Gnostic saviour, the teacher of saving knowledge, into a political-religious leader, the imam, underscores and amplifies this immanentist tendency of Ismailism.

In the early 9th century, there was a sudden rise of interest in Hellenistic philosophy and science in the Moslem world, and the Abbasids embarked on an ambitious programme for the revival of such non-Islamic learning.[1837] Largely relying on Nestorian and Sabian scholars, they established large libraries and university-like institutions, such as the famous House of Wisdom, *Bayt al-Hikma,* in Baghdad[1838], collected Greek and Syrian texts and had them translated into the Arabian language[1839], and sustained many eminent scholars at their centres of learning. Soon, the reverberations of this project in the form of dubious rationalist tendencies within theology, such as the controversial philosophical teachings of the Mutazilites, who, for example, opposed the fatalist and anthropomorphist proclivities of mainstream Islam with rationalist arguments, made themselves felt and provoked an orthodox reaction, which gained full strength under the caliph al-Mutawakkil (847-861), who closed down *Bayt al-Hikma.* Similarly, in Andalusia Hisham consigned to the flames many of the books his father al-Hakam II had collected in the famous library of Cordoba. In time, this reaction would lead to the gradual abandonment in orthodox Sunni Islam of the theologically risky or practically useless of "the foreign sciences", which had largely been dominated by Shiites, Persians, Christians, Jews, and Sabians anyway. The emphasis in Moslem learning thus shifted towards the "traditional disciplines" germane to the study of the Koran (grammar, poetry, history, theology, and jurisprudence), whereas of the "foreign disciplines" only those ancillary to the study of the Koran as pursued by the orthodox scholastic theologians, the *mutakallimun,* and to the practices of Islam (typically logic, arithmetic, and some astronomy) – or otherwise obviously useful – were widely studied.[1840] The new orthodox Sunni attitude is well summed up in al-Ghazzali's division of the sciences into praiseworthy and blameworthy, "the latter including all the disciplines considered to be useless, even harmful, to life on this earth and to the health of the soul in the hereafter".[1841] In contrast,

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[1835] See [Made78a] p. 203 et seqq. and [Halm97] p. 50 et seqq.

[1836] This is the scheme of al-Nasafi, from which the other philosophers deviated on various points. For example, Nasir Khusraw does not include the celestial spheres and intellects in his series of emanations.

[1837] On science and engineering in Islam, see, for example, [Ullm72], [Nasr92], [Hill93], [Turn97], [Saud94], [Olea49], [HH86], [Huff93], [Sabr88], [Ples66], [Sabr87], [Corb93] p. 125 et seqq., [Lind78b], and [Lind92] p. 161 et seqq.

[1838] [Sour60]

[1839] See [Corb93] p. 14 et seqq.

[1840] [Makd90] makes this school-based study of the "traditional sciences" the starting point of both Moslem and Western Scholasticism and Humanism.

[1841] See [Anon71]. On the Islamic attitude to science in general, see [Hood92]. Cf. also [Grun55] p. 111 et seqq., [Sayi58], [Sayi60] p. 407 et seqq., [Saun63], [Sabr88], [Cohe94] p. 384 et seqq., and [Ferk93] p. 119 et seqq.

the Shiite Ismailis, being the arrant enemies of the Abbasids and Sunni Islam, gleefully embraced what their foes shunned and tried to create a grand synthesis of Hellenistic philosophy, science, Islam, and indeed what wisdom they found in other religions as well. Their passion for science/knowledge, *ilm,* tempered with wisdom, *hikma* and gnosis/theosophy, *irfan,* their great body of scholarly and scientific literature, largely authored by their learned dais and other propagandists, their large libraries, and their university-like institutions, such as the famous Fatimid *Dar al-Hikma,* all bear witness to their remarkable scientific-philosophic interests.

Once again, the science of these times must not be confused with modern naturalistic-positivistic science, as is still often the case even in very learned accounts. It was rather of a piece with the esoteric-occult learning pursued by the adherents of the philosophical-religious strains of thought already mentioned repeatedly, i.e. the *Neoplatonism* promoted by many Moslem philosophers and writings such as the pseudo-Aristotelian *Liber de causis* or *Theologia Aristotelis*[1842], the omnipresent *Pythagoreanism* showing, for instance, in the obsession with numerology so typical of Ismaili cosmology and historiosophy, the *Hermeticism*[1843]*,* which was primarily transmitted to the Moslems via the recalcitrant pagans or 'Sabians' of Harran[1844], who produced many eminent scholars and translators[1845], *Gnosticism,* still rife in the Orient at this time, the so-called *Daysanites,* i.e. the semi-Gnostic adherents of Bardesanes[1846], and the dualist *Manichaeans,* who, albeit detested and persecuted by the Orthodox, made a palpable imprint on contemporary philosophical-scientific speculation. Thus, Moslem science was predicated on the basis of the emanationist worldview of late Antiquity, which in its main lineaments was common to Neoplatonism, Hermeticism, Neopythagoreanism, the Kabbalah, and Gnosticism and also was the worldview that, albeit at least as theologically problematical in Christianity as in Islam, was in the focus of the intellectual debate in Western Europe for many hundred years, until it apparently was finally discarded during the 17th-18th centuries – although it still tends to crop up in new guises ever and again.[1847] The lynchpin of this complex of learning were the 'Hermetic' or 'occult sciences' of astrology, alchemy, and magic, all largely based on number mysticism and the theory of an intricate web of correspondences, sympathies, and astral influences between the superlunary and sublunary realms, between the macrocosm and the microcosm.[1848] By characterising the entire Arabic culture as having a magic soul, Oswald Spengler even made the occult the distinctive feature of Moslem culture, although he admittedly used the term "Arabic" very broadly, extending it also to entirely non-Arabic civilisations, such as pre-medieval and Byzantine Christianity.[1849]

Although by no means the exclusive domain of the Ismailis, some of the most famous exponents of Islamic science were more or less closely associated with Ismailism.[1850] Already the imam Djafar al-Sadik, the father of the eponymous Ismail, gained a reputation for his knowledge of the Greek and occult sciences, on which topics there also circulated various writings attributed to him.[1851] Also the very influential alchemist Jabir, the Latin Geber, who, besides, gave himself out as a disciple of Djafar al-Sadik, but, at least according to many modern scholars, perhaps rather lived in the 9th century, belonged to the same revolutionary circles, from which Ismailism sprang in the first place, he himself proclaiming "the imminent advent of a new *im□m* who would abolish the law of Islam and replace the revelation of the Kur'an by the lights of Greek science

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1842 See [Corb93] p. 18. *Liber de causis* is in fact made up of extracts of Proclus' *Elementatio theologica,* whereas *Theologia Aristotelis* is a compilation from Plotinus.

1843 On Hermeticism and Islamic science, see [Corb93] p. 125 et seqq., [Mass44], [Affi51], [Ples54], and [Ples71].

1844 See [Chwo1856], [Gree92], [Hjär72], and [Fahd95]. Cf. also [Åker98] p. 41 et seqq. for some speculations about the possible connection between the Sabians and the Rosicrucian manifestos.

1845 The most famous of these will be the mathematician and astronomer Thabit Ibn-Qurra, who also wrote extensively on the Sabian religion and took an interest in the letter mysticism so typical of this time, the use of talismanic images for magical purposes, astrology, and kindred occult topics. See [RM00] and [Thor23] vol. I p. 661 et seqq.

1846 See [Abel65]. According to [Ming00] p. 11, the Yezidis (or 'Mogul devil-worshippers') are still referred to as Daysanites.

1847 See [Lewi64] and [Lind92] p. 245 et seqq.

1848 See [Ullm72], [Hell95], [Ullm86], [Fahd97], [Hill90], and [Ping90]. Cf. also [Thor23] p. 641 et seqq. et passim.

1849 [Spen97]

1850 See [Nasr92] p. 36 et seq.

1851 See [Hodg65a].

and philosophy".[1852] The corpus of writings ascribed to him is encyclopaedic in scope, dealing with alchemy, medicine, astrology, magic, the qualities of things, the artificial generation of living beings *(takwin),* and the numerological-alphabetical speculations central to his famous science of the balance *(mizan).*[1853] Ibn Yunus, sometimes characterised as the most accomplished of the Islamic astronomers, and Alhazen, whose new synthesis of optics, largely inspired by the light mysticism cultivated in Neoplatonist circles, remained the accepted wisdom of this discipline until the 17th century and whose attempt to regulate the Nile, instigated by the founder of the *Dar al-Hikma,* the "mad caliph" al-Hakim, albeit a failure, prefigure the most daring endeavours of the Faustian spirit to come, were some of the most illustrious scientists working for the Fatimid caliphs, whereas the universal genius Nasir al-Din al-Tusi, just like Averroës famous for his defence of the philosophy of Avicenna against al-Ghazzali's *Destructio philosophorum,* was a resident of Alamut until its destruction by the Mongols.

There are also strong affinities and interdependencies between Ismaili cosmology and philosophy and the Moslem Neoplatonism and Neoaristotelianism of al-Kindi, Albumasar, al-Farabi, Ibn Masarrah, Avicenna, Alhazen, Avempace, Abubacer, Averroës, and others.[1854] So, al-Kindi, just like the Ismailis taking a strong interest in the occult sciences, speculated about the planetary conjunctions as a means for making astrological predictions about political-religious turning-points – for instance concerning the duration of the Arab dominance in the Moslem world – and, in *De radiis,* worked out a theory about the operation of magic through radiation or emanation of occult forces abetted by astrological influences, supporting this theory by occasional references to "experiments".[1855] His pupil Albumasar became the most famous of the Moslem astrologers and wrote extensively on astrological topics, such as "conjunctions" and "revolutions", which he, like the Ismailis, connected with the rise of new religions, political cataclysms, wars, floods, pestilence and the like.[1856] He also advocated the need for astrological considerations in medicine, an idea widely accepted in the Middle Ages, and, much in the vein of the Ismaili flaunting of common religious sentiments, caused a major cause célèbre by his explanation of the Koranic names of God as borrowings from the Syriac. Notably, one of his works was entitled *On experiments.* Al-Farabi, like Avempace, shared a strong interest in utopian politics with the Ismailis and his emanationist philosophy exhibited many terminological and structural affinities with their doctrines. The Andalusian philosopher Ibn Masarrah, whose theosophical teachings also have the *air de famille* of Ismaili thought, founded an Ismaili-like esoteric brotherhood with an Imam as its leader. Albeit himself not an Ismaili, Avicenna was well versed in the Ismaili doctrines, as both his father and brother were adepts of "the religion of truth" and tried, in vain forsooth, to convert him as well. As for Averroës, his notorious doctrine of the double truth will be but a re-formulation of the *batin-zahir* distinction of Ismaili *tawil* exegesis, his conception of history – including the succession of religions – as ruled by astrological necessity was also prominent in Ismailism, and his strict adherence to Aristotle's teachings – prefigured by Albumasar, Avempace, and Abubacer – also on such controversial counts as the eternity of matter and the denial of the *creatio ex nihilo* was also attributed to the higher degrees of Ismaili esoteric philosophy. It should also be noted that Averroës, just like some Ismaili thinkers, set out to refute the orthodox Sunni al-Ghazzali's *Destructio philosophorum* and that his rationalist interpretation of Aristotelianism, which, albeit purified from some Neoplatonic accretions, remained tinged by Neoplatonism, was entirely at odds with the occasionalism of Asharite Sunni orthodoxy.

Just as the way for the French Revolution was paved by the *Encyclopédie* and the *philosophes,* the Ismaili revolutionaries had their own encyclopaedia authored by a circle of learned and free-thinking philosophers. This remarkable work came into being during the heyday of the Carmathians in the 10th century, when they for a time were able to dominate southern Iraq, where the mystical-Hermetic society called *Ikhwan al-Safa,* the

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[1852] [KP65] p. 358. On Jabir, see [Krau31], [Krau86], [KP65], [Corb86] p. 55 et seqq., [Holm90] p. 60 et seqq., [Nasr92] p. 258 et seqq., [Corb93] p. 128 et seqq., and [Thor23] vol. I p. 661 et seqq.

[1853] The similarity of much of this to the Jewish Kabbalah with its letter mysticism and Golem stories is conspicuous. Additionally, we can here discern the embryos of the themes that much later would materialise in the digital computer. See below p. 477 et seqq.

[1854] [Corb93] p. 153 et seqq. points out many of these affinities.

[1855] See [Thor23] vol. I p. 642 et seqq. As *De radiis* was translated into Latin (see [Alki74]) and was read by Robert Grosseteste, Roger Bacon, and others, al-Kindi's theory of magic radiation would have very far-reaching consequences on the development of science, giving the impetus to the naturalistic-experimentalist turn in the West. See also [Lind81] and [Åker98] p. 84.

[1856] See [Nort80] and [Thor23] vol. I p. 649 et seqq. Cf. also [Arjo98] p. 265 et seqq. Albumasar's macrohistorical theories were to be very influential also in the Latin West, where they were studied by, for example, Roger Bacon.

Brethren of Purity, generally believed to have been somehow connected with them, was operative in Basra, doing research on all kinds of topics and collecting the results of their labours in their famous encyclopaedia, the *Rasail.*[1857] This work, strongly suffused by Ismaili theosophy, cosmology, prophetology, and imamology as well as by traces of Neoplatonism, Nestorian Christianity, and Hermeticism, and a strong interest in the Hermetic-occult sciences, consisted of 52 (or 51) tracts on esoteric-scientific lore, in which some even have, albeit on dubious grounds for sure, believed themselves to be able to discern suggestions about heliocentrism and a kind of proto-Darwinism.[1858] *Picatrix,* the rather infamous book – so influential in the Middle Ages and the Renaissance – on how to create magic talismans, which funnel the astral influences postulated by astrological theory, also seems to be connected with the Brethren, perhaps through Maslamah al-Majriti, who disseminated the *Rasail* in Spain and may have written the tract that sums up its contents.[1859] Although the Ismaili activities in Spain are shrouded in mystery, it is interesting to note that the doctrines of the 'Empedoclean' philosopher ibn Masarrah, the first of the Spanish philosophers, and his disciples, being strongly influential also on the famous Ibn al-Arabi, as well as the organisational forms of his school evince many traits that suggest Ismaili influence and, additionally, that the aforementioned al-Majriti founded a school in Cordoba, at which began an efflorescence of science and philosophy in Andalusia and the Ummayad caliphate along similar lines as in Egypt, Iraq, and Persia.[1860] It was also in Spain that the Kabbalists, Raymond Lull, and other mystics and occultists would later revisit and develop many of the mystical-occult themes cultivated by the Ismailis.

We must now conclude this too long divagation on Ismailism, having, however, dwelt on this topic – only rarely dealt with in dissertations in computer science – for a good reason. For, it is impossible not to perceive the first breeze of the Faustian spirit of modernity in the Ismaili hurricane that from the end of the 9th century swept over the Moslem world and, albeit having begun to decline in vehemence by the late 11th century, only finally receded with the fall of Alamut in 1256, although even after this fateful event Ismaili ideas lived on in various sequestered quarters, most notably in some Sufi sects. The ramifications of immanentised Messianic ideas in the form of the innerworldly utopianism, progressivism, and restless revolutionary activism that Voegelin deemed characteristic of the modern Gnostic mindset, here became clearly visible long before the onset of modernism proper.[1861] Also the modern cult of knowledge and the 'Baconian' notion of knowledge as power, as a means to practical, innerworldly ends, came to the fore in the scientific-occult interests so eagerly cultivated by the Ismailis. Notably, the Hermetic pursuits of astrology, alchemy, and, in particular, magic resulted in a large literature of secrets or "experiments", which would provide the incentive for the scientific-occult awakening in the West and the hotbed for the instrumental-manipulative view of knowledge later to become extended to all domains of life through the application of science, technology, "social engineering", and suchlike. It is not difficult to find amongst the Ismaili revolutionaries many other strikingly modern traits, attitudes, tendencies, and perceptions – besides, largely being associated with their pursuit of the occult –, such as their proclivity for Gnostic antinomianism, elitism, and contempt for the established exoteric religion and morality, their belief in the unity of the inner meaning of all religions, their 'spiritual' re-interpretation of such religious concepts as heaven, hell, and the resurrection, their political proselytism and activism, their Platonic-Academic intellectualism and penchant for abstract-mathematical schematisms in metaphysics as well as in historiosophy, to say nothing of the dark – and still very contentious – rumours about them for unrestrained libertinism, hashish eating, and the like.

Yet, the accusations for atheism and materialism – the hallmark of modern academic-scientific secularism – often hurled against the Ismailis by the critics of the sect seem to be rather weakly founded, although it must be admitted that there is in the Neoplatonist pantheism espoused in Ismaili circles a certain predisposition to

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1857 See [Nett82], [Marq73], [Diet69], [Marq71], [Marq66], [Tiba55], [Nasr92] p. 152 et seqq., [Nasr93] p. 25 et seqq., [Fakh70] p. 184 et seqq., [Corb93] p. 133 et seqq., and [Gree92] p. 181 et seqq.

1858 On the "Darwinism" of the Brethren, see [Diet69] vol. IX. The alleged "heliocentrism" they professed was that of the "Chaldaean" geocentric system, where the Sun occupies the central position in heaven, i.e. the middle position amongst the planets, which, in this system, encircle the Earth in the order Moon, Mercury, Venus, Sun, Mars, Jupiter, Saturn – rather than in the order Moon, Sun, Mercury, Venus, Mars, Jupiter, Saturn of the "Egyptian" system. Cf. [Drey53] p. 129 et seq.

1859 See [Ples54] p. 57 et seq. and [Nasr92] p. 51. Cf. also [Gari90] p. 29 et seqq.

1860 Cf. [Daft90] p. 173 and [Corb93] p. 221 et seqq.

1861 According to Voegelin, these three characteristics are immanentisations of the teleological and axiological components of the Christian idea of perfection or *sanctificatio*. See below p. 444.

materialist and atheist derailments, which we can vaguely feel at work in the philosophy of some Moslem Neoplatonists, such as Ibn Masarrah, and observe more clearly in Rhazes' naturalistic despiritualisation of alchemy into pure chemistry or in the dramatic derailment of Western philosophical thought as it unfolded in the development from Renaissance Platonism via Bruno's and Spinoza's "pantheism" further on to Enlightenment, Romantic, and modern philosophy. Additionally, the cynicism and 'practical atheism' of certain of the leading figures of Ismailism may perhaps make the indictments about atheism plausible in particular cases. For example, it is hard to deny the intrinsic likelihood of such suspicions when directed towards such a grim personage as Hassan Sabah, the founder of the sect of the Assassins and the originator of their systematic utilisation of assassinations as a political instrument.[1862] When in 1090 this charismatic, highly gifted ascetic had by his machinations managed to capture the almost impregnable mountain fortress of Alamut in Daylam of North-western Persia, he withdrew into the tower at this desolate cliff, reportedly to appear again in the open air only on two occasions before his death in 1124, devoting himself to studies and writing[1863] in the large library he amassed there – his erudition in mathematics, astrology, alchemy, and magic was highly esteemed also by his adversaries – and regaling himself in his spare-time with the favourite sport of revolutionaries and ideologues of all times, that is to say plotting, scheming, and planning death to others for the promotion of the Great Cause, absolute, abstract Justice, and his own interests – not even recoiling at the execution of both of his sons, one of whom was put to death for the atrocious crime of having imbibed a little wine, the other on the ground of some dubious suspicions – later proven false – of having been implicated in the murder of the chief dai of Kuhistan. As we will now see, the temper of Alamut would not forever stay put at the forlorn crag of Daylam, but in due time its repercussions were destined to be felt all over the globe.

3.3.6 WEST MEETS EAST – THE WESTERN RESPONSE

> *Alle geistigen Kämpfe des Mittelalters finden bei den Arabern ihr Vorspiel.*
>
> *Friedrich Dieterici*[1864]

To many of us, the Middle Ages denote the acme of Western Christian civilisation, from which our culture has since gradually sunken into a deeper and deeper morass of narrow-minded superficiality, idolatry, and undue preoccupation with what on closer analysis turns out to be adiaphora and empty shadows, notwithstanding all the grandiloquent braggadocio by which it is so often extolled by the time-serving adulators of modernity. The omnipresent, intensely Christian piety and mysticism suffusing every nook and cranny of medieval life and society and guiding the Christian *viator* throughout his journey towards the ultimate heavenly goal of man's earthly existence, the pervasively otherworldly-oriented literature with its allegories, symbols, and mirabilia, the sublime tunes and unpretentiously ethereal stanzas of the Gregorian chants, which seem to bring to us a reverberation of the celestial choirs of seraphim and cherubim, the magnificent, heavenward architecture of the cathedrals and castles – the ones made out of stone as well as the compages of perennial philosophy and theology erected by St. Thomas, St. Bonaventure, and the other great Schoolmen – all bear witness to the profundity and serenity of this culture, grounded in its devotion to Christ rather than to the petty, often blatantly self-serving goals currently pursued by the ambitious or voguish, thereby painfully reminding us of the qualities of which our culture has long since been robbed. Not in order to detract from or cavil at this great Christian spiritual and civilisational synthesis, but rather so as to get some purchase on which the destructive forces were that would in the end undermine it and cause its dissolution into the spiritual Maelstrom of Western modernism, now being about to drench all other cultures, civilisations, religions, and spiritualities in an unprecedented deluge of monocultural relativistic-materialistic acid, this and the next section will largely be devoted to some of the byways of medieval culture, which admittedly may look somewhat marginal from the standpoint of medieval history *per se*, as their true import was only to show in the developments that subsequently followed from them.

[1862] See [Juva97] p. 666 et seqq. for one very hostile cameo of him.

[1863] Only fragments of his writings are extant. These include some poetry, parts of his autobiography, and scraps of a theological treatise emphasising the absolute authority of the imam and the importance of total submission to his instructions. See [Hodg55] p. 37 et seqq.

[1864] [Diet69] vol. XIV p. xvi.

As pointed out by Dieterici in the epigraph of the current section, it is as though all the struggles, problems, pathologies, and curses that were to beset Western Christianity from the High Middle Ages onwards first prevailed for a time in the world of Islam, but then mostly somehow fizzled out there, only to be transplanted to the West, where they then tended to take on wholly new proportions and develop in the most unexpected ways. So, once the religiously motivated military expansionism of the Arabs had been barred at Poitiers in 732, the *jihad* ideology was no longer able to propel the Moslem warriors to victories on a par with those of the first centuries of Islam – although it continued to play a certain rôle in the long war against the Byzantine Empire –, whereas it soon re-appeared with new vigour in the crusading spirit of the Latin West, despite its apparent incongruity with the very core of Christian ethics.[1865] The revolutionary activities of the Carmathians, Fatimids, and Assassins all led to counter-reactions and ended up in disillusion, military defeat, or inner breakdown, whereas the revolutionary-utopian, intellectualistic-meritocratic spirit, having been transferred to the West on devious paths, took root firmly here, nay became a distinctive feature of our culture. Likewise, the pursuit of the occult, according to Spengler the most characteristic trait of the 'magic' Arabian culture, did not give rise to the two grand pathologies of the witch-craze and modern despiritualised science and technology until it had been replanted in the soil of the West.[1866] Although the Houses of Wisdom in Baghdad and Cairo and the Islamic *madrasas* were the precursors of the Western universities[1867], Moslem learning never lost its religious foundation or fell victim to the vicious secularism that made itself felt from the start in the Western universities, but even slight tendencies in this direction met with strong opposition and countervailing forces and measures. So the *Bayt al-Hikma* in Baghdad was closed down during the orthodox reaction, which supervened in al-Mutawakkil's caliphate, as was *Dar al-Hikma* in Cairo, when the ardent Sunni

[1865] On the significance of the *jihad* idea in the wars between the Saracens and the Byzantines, see [Bonn96]. Albeit very circumspect in his conclusions, [Noth66] is able to produce some interesting evidence about how the ideology of the Crusades was moulded on the Moslem *jihad* idea. For one thing, there seem to be direct verbal echoes of the Koranic passages on the *jihad* in the writings of Bernard of Clairvaux, the *doctor mellifluus,* who became the foremost Christian theoretician of the Crusades. Also elements of the Western concept of chivalry may be related to similar Islamic notions (see [Corb93] p. 228, [Metl77] p. 117 et seqq., and [Rodi87] p. 26 et seq.).

Since the Enlightenment, it has become popular amongst the despisers of religion to depict the holy war phenomenon in the most lurid colours. But against these vociferous detractors, one may point out that if men now – be it by some inner impulsion or as a consequence of divine punishment – need to engage in warfare and die on the battlefield, as indeed seems to be the case, it will be far worthier and rational to fight for what one believes to be the sake of God and the true faith than for some sovereign of, perhaps, doubtful virtue and mettle, or worse, the grand idol of the national state so unwisely puffed up by the Hegelian-Romantic idolaters, or, worst of all, something as inglorious and petty as a party or an ideology.

[1866] Although we cannot here go into the thorny and extremely contentious issue of the nature and roots of witchcraft – a phenomenon apparently prevalent all over the world since the dawn of history – or the causes and factual background of the great witch-craze of early modern Europe, it should be pointed out that the witch-craze, culminating approximately 1550-1650, is by and large coeval with and doubtless also related to another offshoot of the rise of Western occultism, to wit the "scientific revolution", as has been observed by various scholars, including [Kirs78], [Feye82], [Clar84b], and [Clar97] p. 149 et seqq. Notably, the witch-craze also prevailed most strongly in the areas where there were large numbers of Protestants, which is to say some of the richest, most industrialised, and intellectually most "developed" areas of Europe – see the maps in [Brig98] and [Russ72] p. 268, although the conclusions of the latter is warped by the fact that they predate the exposure of the two forgeries that helped to form the fantastically exaggerated myths around the witch-craze, viz. the Lamothe-Langon counterfeit and the interpolations in the printed editions of Bartolous of Sassoferrato. Cf. also [Whit68] p. 169 et seqq., where the witch-craze is related to various other pneumapathologies of the late Middle Ages and the Renaissance as well as to the societal upheavals that followed upon the establishment of the money economy, rapidly increasing trade, urbanisation, the rise of the national state, etc.

As a matter of fact, the extent and nature of the witch-craze have repeatedly been disfigured by various propagandistic motives and still continues to be so, although the intense research presently going on in the field has been able to do away with some of the worst tales. For one thing, the total number of victims of the witch trials can no longer be estimated at hundreds of thousands or even millions, but is now believed to have been well below 100.000 – educated guesses currently seem to settle on 40.000-60.000 executed witches (see [Leva95] p. 21 et seqq.). Notably, the most vicious witch-hunts tended to happen in areas, where – often during more or less anarchic spells of war or civil war – there was a lack of strong political and ecclesiastical authority and the witch trials were handled by secular, local courts staffed by lay judges, who were easily swayed by popular opinion. Additionally, the popular association of the witch-craze with the Roman Catholic Church and "the Inquisition", largely the outcome of anticlerical and anti-Catholic propaganda, cannot be upheld. At the time of the great witch-craze, the inquisitional courts on the contrary tended to be sceptical of the fantastic popular beliefs about witches – often viewed by the clerical judges as a form of unbefitting, un-Christian superstitiousness –, restrictive in the application of torture, and clement in their verdicts, systematically suppressing any tendencies of witch hysteria in the areas, where their jurisdiction remained effective, such as Spain or Italy (see [Leva95] p. 222 et seqq.). Many other examples of the absurd distortions of historical facts produced by anti-Catholic propagandists have been gathered by [Thur] and [Pern00].

[1867] See [Nako64]. Cf. also [Makd90]. In addition to the *madrasa,* three other important institutions absent from the Greek and Roman cultures, viz. the public library, the astronomic observatory, and the hospital, emerged in the Moslem world, as pointed out in [Cohe94] p. 385 et seq. and [Sabr88].

Saladdin, who also had the books of its library sold, put an end to the Fatimid caliphate[1868], whereas, upon the conquest of Alamut by the Mongols, the Sunnite historian Juvaini, after some rifling, consigned its library to the flames, just as Hisham had done with the theologically dubious books in the library of Cordoba some hundred years earlier.[1869] By the same token, the irreligious or, perhaps rather, freethinking tendencies of the Moslem philosophers met with the *Destructio philosophorum* of al-Ghazzali's sharp pen. Although, as has been emphasised by Corbin[1870], al-Ghazzali's denouncements did not by themselves portend or bring about the end of philosophy in the Islamic world, the kind of theologically troublesome Peripateticism advocated by Averroës would succumb to the religious temper of Islamic culture and could only thrive and grow in the Occident, whereas from about this time the Orient, by and large in the spirit of al-Ghazzali, turned to Islamic orthodoxy, the mysticism of the Sufis, and the theosophical "Oriental philosophy" of the Persian philosopher sages and mullahs.

During the late 11th century, a period of intense contacts between the worlds of Islam and Western Christianity began.[1871] In 1085, Toledo in Spain was captured by Christian troops and soon developed into a major centre of cultural interaction between Christians and Arabs and, in particular, of translation of Arab literature into Latin. Sicily, finally conquered by the Normans in 1091, provided another hub of translation and other cross-cultural activities. The crusades, having begun in 1095, also brought about close contacts with the Moslems of the Middle East and, notably, with the Nizari Ismailites in Lebanon and Syria. At the same time as Islam was losing much of its original hectic fierceness and the Moslem world increasingly turned inwards, the Latin Western culture, struggling to catch up with the Mussulman and Byzantine cultures after the spell of cultural decline that had followed upon the fall of the Roman Empire and the Great Migration, went through what can only be characterised as an extraordinary Faustian mutation, rapidly drifting – in Sorokin's terminology – from the ideational towards the sensate.[1872] Attempting to cope with the bountiful intellectual treasure-trove that now little by little was ransacked and robbed of the gems as well as the counterfeit gold amassed there by the various – philosophical, theological, and occult-scientific – traditions of thought, the Western mind fell into a deep crisis from which it never really recovered, being, as it were, overcome and bedazzled by the diversity, paradoxicality, and dialectical garishness of all these challenging ideas, theories, interpretations, and thought structures. The daring forms of the Gothic cathedral, which now supplanted the modest otherworldliness of Romanesque architecture, will stand as the prime symbol of something new and exceedingly bold, a boundless and heedless extremist pother that in due time was to undermine the fundamental harmony and simplicity of medieval Christian culture and bring about the grand woes and pathologies of the Renaissance, the Reformation, and the scientific and political revolutions of the 17th and 18th centuries.

By and large, we can divide the novel strains of thought into five groups, which during the High Middle Ages presented a formidable challenge to the Western mind:

- *Neoplatonism* and *Neoaristotelianism* had been forged into a synthesis of Platonist emanationism by such philosophers as al-Kindi, al-Farabi, and Avicenna, whose intrinsically pantheist mysticism, based on the conception of the *intellectus agens,* the angelic-divine active intellect, which as *dator formarum* both endows the matter of the sublunary sphere with form and projects the forms into the individual human soul so as to enable it to abstract them from their substratum by, as it were, energising the soul's innate *intellectus possibilis* or passive intellect. This Arabian Neoplatonism interacted complexly with the already strong Platonic (and Aristotelian) traditions of the Latin Occident, propagated through Plato's *Timaeus* and in the works of St. Augustine – with its gnosiology of divine illumination –, pseudo-Dionysius Areopagita, John Scotus Eriugena, the philosophers of the School of Chartres, and others.

[1868] However, already in the 1060s, the *Dar al-Hikma* had been plundered and most of its manuscripts scattered. See [Halm97] p. 77 et seq.

[1869] Some more stories about the destruction of libraries are recounted [Nako64] p. 71 et seqq.

[1870] See [Corb93] p. 184 et seqq.

[1871] See [Hask24], [Watt72], [Metl77], [AH96], [Fück55], [Schi61], [Rodi87], and [Makd90]. Cf. also [Dane93] and [Sout62]. On the possible Moslem sources of Dante, see [Pala97], [Caba20], [Silv52], and [Kenn96]. Cf. also [Corb98].

[1872] The classical work on the Renaissance of the 12th century is [Hask57]. See also [Chen97].

- *Aristotelianism* likewise was often slanted in theologically deeply problematical ways during the Middle Ages, inasmuch as the Latin translation of the Aristotelian corpus now becoming available was read through the spectacles of the commentaries written by Averroës – simply referred to as the *Commentator* by the Schoolmen – and by Alexander of Aphrodisias rather than, as had been the case in the Moslem world, in the light of Neoplatonic pseudepigrapha, such as *Liber de causis, Theologia Aristotelis,* and *Liber de pomo*. Whereas Alexandrism tended towards naturalism, Averroism was characterised by such preposterous notions as the doctrine of the double truth, the monopsychic-pantheist construal of both the *intellectus agens* and the *intellectus possibilis* as trans-individual, the notion of matter as *principium individuationis,* and the denial of the immortality of the human soul and the *creatio ex nihilo* of the cosmos.

- *Ismaili Gnosticism* and *Hermeticism,* primarily disseminated through the enormously popular underground literature on occult secrets – although also more direct attempts at proselytising, in particular in the areas where Moslems and Christians lived side by side, certainly also occurred –, promulgated a mixture of Neoplatonism, Hermeticism, Messianic-astrological speculation, utopianism, and an ardent interest in the 'occult sciences' of astrology, alchemy, and magic.

- *The Jewish Kabbalah* now also began to make its occult-mystical influence felt, particularly in Spain and Provence, where sizeable Jewish populations existed and many erudite Jewish scholars, philosophers, mystics, and magicians lived.

- *Catharism* was a missionary, dourly dualistic-Manichaean sect, originating in heretical Gnostic groups on the Balkans (and, perhaps also, in the Orient).[1873] It recognised a single sacrament, the spirit baptism or *consolamentum,* which, by analogy with the Moslem Neoplatonists' conception of a union of the human intellect with the active intellect, was intended to re-unite the soul of the believer to the "the holy spirit", conceived of as man's heavenly counterpart or guardian angel.[1874]

The massive influx of these Neoplatonic, Aristotelian, and Gnostic-Hermetic ideas into the Latin West from the Moslem and, to a lesser extent, Byzantine worlds during the High Middle Ages naturally caused considerable concern to the ecclesiastical authorities and faithful Catholic theologians, in particular in the light of the appearance and rapid dissemination of various, from an orthodox Christian point of view, highly suspicious teachings based on them.[1875] These dangerous novelties included the pantheist philosophy of Amalric of Bène, the tutor of the French king Louis VIII, and his Amalrician followers, who reportedly taught that God was the *forma mundi,* the form of the world[1876], and the pantheist materialism of David of Dinant,

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[1873] That there was a connection between the Cathars and Albigenses and ancient Gnosticism, or to be more precise, Manichaeism, via the Bogomiles of Bulgaria, the Paulicians of Byzantium and Armenia, and the ancient Messalinians of the eastern provinces of the Roman Empire, is usually assumed, although the details of this history are far from clear and there are a few scholars, who have tried to play the Manichaean influence down and consider other possible intellectual sources of Catharism, such as, for instance, Visigothic Arianism. See [Döll82], [Runc47], [Söde49], [Moor77b], [Wils84], [Bors91], [Lamb92], [Broe98], [Lans98], [Lamb98], [Barb00], [Stoy00], and [Weis01]. Cf. also [Brow84] p. 246 et seqq. On the history of the historiography of Catharism, see [Anon79].

[1874] See [Broe98] p. 96 et seqq. See also footnote 1718 on p. 365 above.

[1875] On the relation between faith and reason in the Middle Ages, see [Gils38].

[1876] There are so many parallels between the doctrines espoused by the Amalricians and the contemporaneous Nizari Ismailism that it seems worthwhile to consider whether Amalricianism may indeed be but a slightly Christianised form of "post-resurrection" Nizarism. The *Catholic Encyclopedia* (see [Abec1907]) gives the following outline of the Amalricians' faith:

"The Amalricians, like their founder, professed a species of pantheism, maintaining, as the fundamental principle of their system, that God and the universe are one; that God is everything and everything is God. This led them, naturally, to the denial of Transubstantiation, the confounding of good and evil–since good and sinful acts, so called, are equally of God–and to the consequent rejection of the laws of morality. They held, besides, peculiar views on the Trinity, distinguishing three periods in the Divine economy with regard to man; the reign of the Father, become incarnate in Abraham, which lasted until the coming of Christ; the reign of the Son, become incarnate in Mary, which had endured until their own time; and the reign of the Holy Ghost, which, taking its beginning from the dawn of the twelfth century, was to last until the end of time. Unlike the Father and the Son, the Holy Ghost was to become incarnate, not merely in one individual of mankind, but in every member of the human race. Moreover, as the Old Law had lost its efficacy at the coming of Christ, so, in their day, the law of the Gospel was to be supplanted by the interior guidance of the Holy Ghost, indwelling in each human soul. In consequence of this they rejected the sacraments as obsolete and useless. Those in whom the Holy Spirit had already taken up His abode were called "the spiritualized", and were supposed to be already enjoying the life of the Resurrection. The signs of this interior

who, somewhat similarly, held that God was the *materia mundi*, i.e. not the form, but the primary matter or substrate of the world[1877], as well as the obdurate Averroism of Siger of Brabant and Boethius the Dacian, who, under the cover of the doctrine of the double truth – i.e. the notion that one truth is valid in philosophy and another in theology –, temerariously put in doubt fundamental Christian tenets on, for instance, the immortality of the soul and the temporal creation of the world *ex nihilo.*[1878] Another formidable threat to Catholicism was presented by the dualist, neo-Gnostic dispensations of the Cathars, Patarenes, and Albigenses, whose alarming expansion in the 12th and early 13th century could only be stemmed by the extreme measures of crusade and Inquisition.[1879]

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illumination were the rejection of faith and hope, as tending to keep the soul in darkness, and the acceptance, in their place, of the light of positive knowledge. It followed from this, that in knowledge and the acquisition of new truths consisted their paradise; while ignorance, which meant adherence to the old order of things, was their substitute for hell."

Almost every item of this agenda can be construed as reflecting some doctrine of the Nizari Ismailis, who, for example,

i) espoused Neoplatonic emanationist *pantheism* – Amalric's pantheism was aptly, but perhaps mistakenly, imputed to Eriugena's Neoplatonic influence by his contemporary critics

ii) held that God had, in sequence, incarnated in the patriarchs, in Christ, in Mohammed, and in the imams, and, after the last (seventh) world week had begun through the *qiyama* or "Resurrection" proclaimed in 1164, in all believers, who together were supposed to constitute a "temple of light" (see [Corb86] and [Corb93] p. 91) – these peculiar doctrines strikingly parallel the Amalricians' odd belief in already being resurrected and in the possession of the Holy Spirit as well as their insistence on the need for each Christian to be a member of the *corpus Christi*

iii) tended to abrogate the religious law for antinomianism and the direct guidance of the "Holy Ghost", which in mystic Islamic philosophy usually was equated with the active intellect or the guardian angel – besides despising the sacraments and other religious practices, the Amalricians were also accused of antinomianism

iv) interpreted heaven and hell as spiritual states, just like the Amalricians

v) tended to reject the faith and hope of positive religion for Neoplatonism, gnosis, and the pursuit of the (occult) sciences in the same way as the Amalricians

vi) took a strong interest in the occult arts, which might have interested the Amalricians as well, as indicated by the epithet "aurifex", alchemist (so [Cohn70a] p. 152), of the prophet of the Amalricians, William Aurifex

vii) had a strong liking for eschatological-Messianic speculations – in addition to their teaching of the three ages the Amalricians attributed an eschatological rôle to Louis VIII, to whom Amalric had been the tutor

viii) exhibited a strong missionary zeal, using missionary methods largely reminiscent of the Amalricians.

Although some of the attitudes shared by Ismailis and Amalricians may have developed independently, such ideas as the incarnation of God in the patriarchs and the spiritual interpretation of the Resurrection seem so peculiar that it is hard to believe that they are unrelated. On Amalric and the Amalricians, see [Dick89], [Albe76], [Thij96], [Abec1907], [Vern37], [Hödl78], [Cape32], [Alve49], [Alve51], [Baem1893], and [Baem26]. It should be noted that there are various traces of Ismaili missionary activities afar off. For example, a 10th century Fatimid source (see [Daft90] p. 228) mentions twelve regions *(jazair)* of the Ismaili *dawa* (obviously excepting the Fatimid caliphate itself), viz. Arabia, Byzantium, the Slavs, Nubia, the Khazars, India, Sind, the Negroes, Abyssinia, China, Daylam (in Persia), and the Berbers, whereas a later list substitutes the Turks for Nubia. The Ismailis are also known to have had proselytes in Hungary and Spain (see [Bali50] and [Daft90] p. 173).

1877 See [Kurd76] and [Turn1908]. The notion of *materia prima* as the first *hypostasis,* corresponding to Plotin's One, was prominent in the pseudo-Empedoclean writings that circulated in the Moslem world, being espoused by the Andalusian philosopher Ibn Masarrah, who, in turn, influenced various other philosophers, such as the Jewish thinker Avicebron and the famous theosopher Ibn al-Arabi. See [Corb93] p. 221 et seqq. Cf. also [Ster60]. Also in alchemy, the *materia prima* played an important rôle.

1878 Averroism was cultivated in some quarters, notably at the University of Padua, and had a second efflorescence in the 16th century, when the naturalist Alexandrist interpretation of Aristotle, espoused by Pomponazzi and others, also gained rapidly in popularity. Notably, both Cusanus and Galileo spent several years at Padua and the Paduan Averroists played an important rôle in the preparation of the "scientific revolution". See [Mand11], [Grab26] vol. II p. 239 et seqq., [Grab31], [Rand40], and [Leam88] p. 161 et seqq. On the questioning of the immortality of the soul, see [Plut86].

1879 Although it cannot be denied that the nature of these measures will often offend the tolerant sentiments promoted in today's "multi-cultural" society and also occasionally may seem hard to reconcile with the ethical tenor of the religion that teaches us that we shall give the coat to him who takes away our cloak and bless them that curse us, Protestant controversialists and, more lately, pro-Gnostic, Christianity-hating, or generally anti-religious modernist historians have often indulged in a very facile form of moralisation over the Inquisition, the crusades, and the various other steps taken by the Roman Catholic Church in order to save Christianity and the souls of the Christians from the, from a Christian perspective at least, inherently evil forces that tried to lead Christian men astray on their pilgrimage to Heaven, playing down or neglecting both the deadly menace to the Christian faith and the nature of the calamities that occasioned these extreme measures, without which Christianity might have ceased to exist altogether. Additionally, recent studies of the inquisitional tribunals, such as [Pete89], have revised the picture of these courts fundamentally, liberating it from the fantastic vituperative exaggerations and distortions of the Protestant and Enlightenment polemicists and, thus, providing a much more believable view of the inquisitional procedures, the frequency of the convictions, and the motives, opinions, and beliefs that made the Church establish these

From the late 12th century, millenarian expectations – often combined with and fomented by astrologically based macrohistorical speculations in the tradition of Albumasar[1880] – concerning the eschatological events and the irruption of spirituality believed to be close at hand began to become rampant, being quite similar in character to the Ismaili millenarianism still rife in the Moslem world. The main author of Christian millenarianism was Joachim of Fiore, who, after a sojourn in the Holy Land, worked out his historiosophical theories based on a batinistic-numerological scheme of Biblical exegesis, for which he believed himself pre-eminently well endowed through the gift of a special *intelligentia spiritualis,* i.e. a knack for spiritual (batinist) interpretation of the Holy Writ, promulgating on the basis of his own involved calculations the imminence of the third age *(status)* of the Spirit, the age of spiritual illumination, which was to follow – according to the estimates of some Joachimite millenarians, in the year 1260 – upon the current age of the Son (i.e. Christian era), as it had, in turn, ensued upon the age of the Father (i.e. the pre-Christian era).[1881] The eye-catching similarities of these speculations with Ismaili Messianism and Ismaili astrological-numerological theories, with which Joachim might have become familiar during his stay in Palestine or at home in Calabria – Calabria, abutting on the isle of Sicily, which only recently had been liberated from its Moslem rulers, had a sizeable Saracen population[1882] – make it seem possible or even likely that Joachim forged his macrohistorical theories and vaticinations under at least some kind of Ismaili influence, perhaps as a Christian response to the challenge it provided.[1883] Interestingly, the Amalricians, for which there do exist even stronger indications of

tribunals in the first place and the Christian world to accept and support their doings. The traditional Catholic viewpoint, essentially substantiated by these researchers, is well summed up by [Wilh10]:

"The Church's legislation on heresy and heretics is often reproached with cruelty and intolerance. Intolerant it is: in fact its *raison d'être* is intolerance of doctrines subversive of the faith. But such intolerance is essential to all that is, or moves, or lives, for tolerance of destructive elements within the organism amounts to suicide. Heretical sects are subject to the same law: they live or die in the measure they apply or neglect it. The charge of cruelty is also easy to meet. All repressive measures cause suffering or inconvenience of some sort: it is their nature. But they are not therefore cruel. The father who chastises his guilty son is just and may be tender-hearted. Cruelty only comes in where the punishment exceeds the requirements of the case. Opponents say, precisely; the rigours of the Inquisition violated all humane feelings. We answer: they offend the feelings of later ages in which there is less regard for the purity of faith; but they did not antagonize the feelings of their own time, when heresy was looked on as more malignant than treason. In proof of which it suffices to remark that the inquisitors only renounced on the guilt of the accused and then handed him over to the secular power to be dealt with according to the laws framed by emperors and kings. Medieval people found no fault with the system, in fact heretics had been burned by the populace centuries before the Inquisition became a regular institution. And whenever heretics gained the upper hand, they were never slow in applying the same laws: so the Huguenots in France, the Hussites in Bohemia, the Calvinists in Geneva, the Elizabethan statesmen and the Puritans in England. Toleration came in only when faith went out; lenient measures were resorted to only where the power to apply more severe measures was wanting... The history of heresy verifies this prediction and shows, moreover, that the greater number of the victims of the sword is on the side of the faithful adherents of the one Church founded by Christ."

Although the Albigensian crusade instigated by Innocentius III, having extended over more than three decades (1208-1243), finally succeeded in suppressing the poison of Catharism, the extirpation of this vicious heresy was soon to be ensued by a proliferation of clandestine heretical movements, which in the end would be instrumental in breaking up Western Christianity. From this selfsame crusade, which, despite the objections of the pope and other representatives of the Church, had been pursued with much cruelty and greed by Simon of Montfort and the other French noblemen, France also emerged as a strong, well-consolidated national state led by increasingly wayward and contumacious princes, who in due time – that is to say in the era of the ignoble "Babylonian captivity" – would not even shy away from making the pope their own prisoner in Avignon, thereby once and for all subverting the credibility of the project of a unified Christian superstate under the leadership of the Holy Father.

[1880] See [Nort80] and [Åker98] p. 74, p. 202 et seqq. et passim.

[1881] On Joachim and his influence, see [Reev77], [Reev69], [Reev99], [Anit31], [Huck38], [Grun66], [Grun77], [Wend74], [WZ83], [West75], [McGi85], [McGi94b], [Bett31], [Bloo57], [Borg94], [RG87], [Leff67] p. 51 et seqq., and [Cohn70a] p. 108 et seqq. See also below p. 442.

[1882] Although Sicily was, formally at least, under Fatimid suzerainty for almost 200 years, it does not seem that Ismailism became very influential on the religious and cultural life of the island, which was instead dominated by fundamentalist Maliki Sunnism (see [TOG97b], [Daft90] p. 156, and [Ahma75] p. 37 et seq.).

As the Ismailis, just like most other Shiites, accepted the doctrine of *taqiyya,* according to which it was acceptable to dissimulate one's religious faith in case of danger or expedience, it seems possible that they may have feigned conversion to the Christian faith when convenient, as they in fact are known to have done occasionally during the crusades. Indeed, as their deeper religious concerns were with the *batin,* the inner meaning behind all religious revelations, rather than with the superficial *zahir* aspect of religion, it might be argued that the outward avowal of this or that religious belief would not be a matter of such great importance to them. See [Lewi40] p. 93 et seqq., where a kind of "interconfessionalism" is attributed to the Ismailis, although others, such as, for example, [Ster83] p. 84 et seqq. and p. 297, have cast doubt on this idea.

[1883] So also [Frèr73] p. 166 et seq. Cf. also [Hana77] p. 95 et seqq. On Islamic apocalypticism, see [Arjo98] and [Cook01]. Joachim's father was a notary – and, in fact, Joachim was brought up so as to become one as well – at the Sicilian court, where Christians and Moslems, some of whom may have been Ismailis, mixed freely (see [McGi80] p. 97 and [Grun60]). It may also be interesting to note that Joachim

some kind of an Ismaili connection, also advocated a tripartite historiosophical scheme very similar to Joachim's.[1884]

Although Joachim to all appearances wished to remain an obedient son of the Church and also enjoyed papal support for his work, the perilous, revolutionary implications of his speculations soon became obvious. Not only can the shadows of these be detected in such outbreaks of prophetic-apocalyptic frenzy as, for example, the children's and the shepherd's crusades in 1210 and 1251 respectively, but from the early 13th century onwards, they were instrumental in fomenting intense guesswork and rumours about the time of the advent and the identity of Antichrist, the great enemy of Christ expected to appear in the last days, as well as about the various beasts and other figures of the Revelation of St. John, about angelic and false popes, about the date of the onset of the awaited spiritual age, the millennium or "Sabbath day" of the world week, and other similar topics.[1885] In 1254, the Franciscan Gerard of Borgo San Donnino caused a scandal by the publication of the *Evangelium Aeternum,* a work consisting of three of Joachim's writings and an introduction and commentary by Gerard, in which he claimed that as the spirit of life had left the New and Old Testaments around 1200 and the new age of the Holy Spirit was now imminent, these Biblical Testaments were now to be superseded by the *Evangelium Aeternum.*[1886] Amongst the heretics, schismatics, enthusiasts, sectarians, rabble-rousers, social revolutionaries, and various self-proclaimed *viri spirituales* of this or that new "spiritual Church", such as the Albigenses, the Amalricians, Gerald Segarelli's and Fra Dolcino's Apostolic Brethren, and the Franciscan fringe groups of zealot spirituals and Fraticelli, whose expansion the Catholic Church now had to struggle hard to hold back, and also in the entourage of the emperor Frederick II, the great antagonist of papal supremacy, the idea that the pope or the papacy was Antichrist and the Roman Catholic Church Babylon, the *meretrix magna* or "carnal church", and great adversary of the true "spiritual church", quickly gained currency. Even such a learned and essentially orthodox prelate as Robert Grosseteste, the Bishop of Lincoln and the celebrated founder of "experimental science", lent some support to this preposterous identification of Antichrist, whereas many others held the enigmatic, possibly crypto-heretical emperor Frederick II to be not the Messiah some of his adherents proclaimed him to be,[1887] but rather the awaited foe of our Lord.[1888] All these

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believed that the Saracens and the Patarenes (a Cathar group active in the vicinity of Joachim's quarters in Calabria) were about to conspire against Christianity (see [Reev69] p. 9, [Reev77] p. 23 and [Stoy00] p. 197).

1884 [Reev77] p. 2 points out that somewhat earlier during the 12th century Rupert of Deutz and Anselm of Havelberg had toyed with ideas about a progressive revelation of the Trinity in history. Cf. [Whit90a] p. 12, where Rupert's idea that man's image-likeness to God could be defined "in terms of skill in all the arts, including crafts" is discussed. See also [Kaml35] and [Dick87].

1885 See [McGi94b], [Reev77] p. 29 et seqq., and [Cohn70a] p. 108 et seqq.

1886 This scandal took on such dimensions that John of Parma, the general of the Franciscans, had to be replaced with St. Bonaventure as the head of the order. St. Bonaventure held this office until his own death – possibly occasioned by poisoning! – at the Council of Lyons in 1274. Also St. Thomas Aquinas, another enemy of Joachimism, died in 1274, shortly before this same Council, which, besides, also finally sealed the break between the Western and Eastern branches of Christianity. The concept of the *Evangelium Aeternum* or "everlasting gospel" derives from *Apoc. 14:6*. On the importance of this concept in the radical Joachimitic tradition in England (Ranters, Muggletonians, Levellers) down to William Blake, see [Mort58].

1887 Somewhat later, the heresiarch Fra Dolcino, some Franciscan extremists, and the famous occultist Arnold of Villanova would attach similar expectations to 'the third Frederick', Frederick of Trinacria, another Hohenstaufen king of Sicily. See [Reev77] p. 63 et seq.

1888 Frederick II – the "stupor mundi" and "immutator mirabilis" in the words of Matthew of Paris' famous characterisation – belongs to a group of personages, whose doings and utterances aroused dark suspicions amongst their contemporaries and gave rise to many curious legends – others that can be included in this category will be, for example, the scholar-occultists Michael Scot, Arnold of Villanova, and Roger Bacon. Of these, Michael Scot (see [Thor65]) was actually the court astrologer of Frederick for many years and, possibly at his instigation, translated many of Averroës' controversial works, which also inspired some of the unsettling questions Frederick dispatched to various philosophers and scholars about, inter alia, the eternity of the world and the immortality of the soul, most famously answered by the enigmatic Moslem philosopher and suicidal mystic Ibn Sabin (see [Corb93] p. 263 et seqq.). Frederick's licentiousness, absolutist way of ruling, and proclivity for Oriental luxury and despotism – including such eyebrows-raising customs as the *proskynesis* and the sustenance of a harem, which, at that, reputedly included also non-Christian ladies –, his involvement with the Ghibellines, amongst whom were many Cathars, his sympathies for and friendships with Jews and Saracens – he even brought Saracen troops with him on his crusade –, his subsidies to the Assassins and friendly relations with Moslem princes, his Messianic pretensions, which may well owe something to Ismaili Messianism, his interest in Aristotle's writings as interpreted by the suspect commentators Alexander of Aphrodisias and Averroës, his aforementioned correspondence with Moslem as well as Christian philosophers and scholars, his purported assent to the legend of the three impostors – which, however is rejected by [Grab26] vol. II p. 137 (but cf. also [Sout62] p. 75 and [Kant28] vol. I p. 455 et seq.) – and denial of the virgin birth of our Lord, and his struggle against papal authority and ensuing excommunication all conduced to his reputation as a crypto-Moslem, heretic, rationalist, or atheist. His son Manfred apparently shared some of his father's interests, as he is reported to have created a "house of science" at Lucera and have had another of Averroës' commentaries translated into Latin. See [Kant28], [TOG97b] p. 587 et seq., [Hask24] p. 242 et seqq., [Grab26] vol. II p. 103 et seqq., [Clev72] p. 283 et seqq. et passim, and, playing down both Frederick's significance and eccentricity, [Abul88] p. 251 et seqq. et passim.

overheated speculations were to be fervently elaborated during the following centuries, repeatedly bearing fruit of questionable merit, of which the grapes of wrath and dissension to be reaped during and after the Reformation – a term *(reformacio),* which, by the way, was used by the Joachimite enthusiasts already in the 13th century to designate the great change associated with the advent of the coming Age of the Spirit – will stand out as the most remarkable and lamentable. In the dramaturgies put together by Löwith, Voegelin, and Cohn and some other explorers of the historical background of the great lunacies of the 20th century, the pious and ascetic abbot from Calabria has even been made to play the part of the great culprit of history, who inaugurated the derailed millenarianism that would culminate in the Communist and Nazi implementation of the millennial dreams.[1889]

One leading intellectual much concerned with Joachitic prophecy and Albumasar's astrologically based macrohistorical speculations as well as with most other novelties then in the air was the erudite Franciscan friar Roger Bacon. Being well versed in most branches of learning and particularly in the occult sciences[1890], he was together with Robert Grosseteste the first major proponent of *scientia experimentalis,*[1891] which he envisioned as a vehicle for the exploitation of the various *experimenta* or "recipes" suggested in the *libri secretorum,* the books – largely of Ismaili origin – of occult secrets, and in other kindred literature on alchemy, astrology, and magic then being rapidly translated from the Arabic language into Latin.[1892] In his *Magical Letter,* Bacon made his famous pronouncements about the possible feats of technology – automobiles, aeroplanes, submarines, outlandish weapons, etc. –, for which he in vain tried to interest the Roman pontiff so as to make the Christians better prepared against the expected onslaught of Antichrist, thereby in effect welding together the pursuit of the occult arts and technoscientific progressivism with Joachitic-Ismaili immanentised eschatology into the "technomillenarianism" that would in due time become the very sap of Western civilisation.[1893] Although some of Bacon's technical devices would be long in coming, it was during the High Middle Ages that the new Western openness to technical innovation, "progress", and the harnessing of *scientia* for the sake of *magia,* power, and utility, of which Roger Bacon stands out as the foremost advocate, began to germinate, as also reflected in the large number of new inventions that were introduced and accepted during this period,

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[1889] See [Löwi53], [Voeg97], [Voeg87], and [Cohn70a]. Cf. also [Taub91].

[1890] See [Thor23] vol. II p. 616 et seqq. and [Moll74].

[1891] On Roger Bacon, see [East52], [Crow50], [Litt14], [Breh76], [FU71], and [Lind87]. On Robert Grosseteste, see [McEv82], [McEv00], [Crom53], [Call55], and [McEv95] and http://www.grosseteste.com. Whether legendary or not, the peculiar "experiments" attributed by Salimbene to Frederick II are quite revealing as to the new spirit of scientific curiosity and experimentalism then in its throes. In order to find out which language was the original one, Frederick, we are told, ordered a number of babies to be taken from their mothers and given to nurses strictly forbidden to talk to them. The experiment did, however, not fall out well, as all the babies died, according to Salimbene by the sadness and distress caused by this harsh treatment. In another hideous experiment two men were treated with an opulent meal and then one was sent out hunting, whereas the other was ordered to go to bed. Later, doctors dissected the two men and examined the contents of their intestines in order to determine, whether it would be preferable from a digestive point of view to move around or take a nap after dinner. Whether the human "guinea pigs" survived this treatment, Salimbene does not tell, but it was found out that the after-dinner nap was preferable. See [Hask24] p. 262 et seq.

[1892] See [Eamo94] p. 38 et seqq., [Ferg59], and [Metl77] p. 89 et seqq. and p. 106 et seqq. Cf. also [NG01] and [Eise80] p. 272 et seqq. Amongst the most influential of these Ismaili works on the secret sciences was the magical treatise *Picatrix,* the corpus of alchemical tracts attributed to Geber, and, in particular, the pseudo-Aristotelian *Secretum Secretorum.* The latter, a compilation of diverse materials, which include portions culled from the *Rasail* of the *Ikhwan al-Safa* as well as a plethora of other sources, was, according to one scholar, "the most popular book of the middle ages" (Gaster cited in [Thor23] vol. II p. 267; [Eamo94] p. 45 et seq. estimates the number of extant manuscripts at around 500; cf. also [Hask24] p. 137 et seqq.). This work was widely believed to reveal the esoteric-occult meaning of Aristotle's doctrines, which is to say the secret of how to take practical advantage of the Aristotelian *scientia.* For one thing, its content made an overwhelming impact on Roger Bacon, whose ideas about experimental science were gestated under its influence. Most books of secrets gave themselves out as revelatory in nature, being attributed to divine, angelic, or demonic agents, typically through the convention of a story about the miraculous discovery of the book in a temple or some other sacred place. In Antiquity, such books were primarily fabricated in Hermetic-Gnostic circles – Mani for one wrote a book of secrets (or mysteries), which seems to be related to a similar work by Bardesanes, and another one on the giants, which possibly drew on *The Book of Giants* of the Qumran sect (see [Verm97] p. 513 et seqq., [Henn43], and [Lieu85] p. 5, 33, and 44). It is possible that some occult literature was propagated also via the dualist Cathars, as the Manichaeans were known to be accomplished astrologers and magicians (see id. op. p. 109 et seqq.). According to [Wils84], alchemical lore was disseminated by the Cathars to the West from the Messalinians, who like certain other Gnostic groups had adopted alchemical practices early on. It may also be noted that in the Jewish *Book of Enoch*, which apparently was read by many early Christians, the secret arts were strongly anathematised, being associated with the fallen angels. On the Medieval Jewish attitudes to the secret arts, see [Rude95] p. 14 et seqq.

[1893] See [Baco88]. Many famous inventors, visionaries, and fantasts through the centuries, such as Michelangelo, Joseph Glanville, Emmanuel Swedenborg, and Jules Verne, would return to these same Baconian themes.

such as the clock, the compass, the spectacles, and gunpowder, just to name a few of the more spectacular ones.[1894]

As pointed out above, the attitude of early Christianity towards the magic arts, as epitomised by Christ's paradigmatic rejection of the three temptations, was uncompromisingly dismissive.[1895] During late Antiquity, a wide gulf thus opened between orthodox Christianity on the one hand and Gnosticism, Hermeticism, and Neoplatonism on the other in the valuation of the secret arts – magic, theurgy, alchemy, and astrology –, the persistence of which was odious, or at least highly problematic, in a Christian society. Only in the High Middle Ages, a renaissance of the secret arts took place through the infusion of magic-scientific literature from the Arabs.[1896] Significantly, technological-mechanical inventiveness and curiosity about the secrets of nature were at this time widely associated with a sinful interest in the black arts, in which Roger Bacon and so many medieval intellectuals were in fact eagerly dabbling, although he and some other scholars, taking their cue from al-Kindi's treatment of the operations of stellar influences in *De radiis*[1897]*,* tried to paper over these associations by the distinction between admissible *natural* and sinful *diabolic magic,* of which only the latter, they contended, implied a condemnable trafficking with evil spirits and powers.[1898] This distinction provided the starting-point for a programme of 'natural' explanation in terms of innerworldly causation of phenomena hitherto regarded as praeternatural or supernatural and also helped to undermine the resistance to technical innovation, which now slowly began to lose some of its traditional demonic connotations. Nevertheless, technical novelties were still generally looked upon with mistrust, in the popular mind often being associated with highly suspect activities, such as the retrieval of knowledge through the infamous theurgic *ars notoria,* the art of conjuring up angels and demons.[1899] Bacon himself emphasised the importance of secrecy and a veiled diction in order to avoid the disclosure of potentially dangerous knowledge to people who were not prepared to handle it.

The papacy is often said to have reached the pinnacle of its influence and authority in the early 13th century during the reign of Innocentius III (1198-1216), who when he died in 1216 had made kings his liegemen, seemingly re-united Christianity under his own leadership, and if not stamped out, at least substantially weakened the heresies that presented Western Christianity with such a terrible menace at this time. But these apparent victories of the seemingly invincible *ecclesia militans* may also be construed as a major peripety in the history of the West, in the aftermath of which we still live. We have in this section touched upon some of the forces that brought about this peripety, although our treatment of these has by necessity been very condensed and incomplete. Additionally, exactly how the revival of the occult arts, the movements of Catharism and Amalricianism, various extreme forms of Franciscan spiritualism and Joachimist prophetic-spiritualistic speculation, monopsychic Averroism and other dubious, heretic, or Neoplatonising interpretations of Aristotle, and the Neoplatonic tradition going back to Eriugena, pseudo-Dionysius and the

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1894 See [Whit62], [Gimp77], and [Sund93] p. 90 et seqq. [Kren85] provides a good bibliography of medieval science.

1895 See above p. 375. There has been a recent trend in some scholarly quarters to talk about "Christian magic", the Christian saints as shamans, and even about Christ as a magus (see [Aune80], who himself is infected by this tendency), this in effect being little more than yet another manifestation of the relentless hatred of Christianity that all since the 18th century has besotted and beclouded so many scholarly minds and brought forth such mighty torrents of erudite insipidness. But in fact, there is an unbridgeable abyss between the manipulative, demanding will- and power-oriented attitude of the magus, who, typically by some abominable, nonsensical magical manipulations, attempts to compel the demons to pursue his own selfish or evil ends – as amply illustrated in, for example, the magical papyri of late Antiquity and the grimoires of the Middle Ages –, and the Christian attitude of *faith,* which, albeit being capable of working mightier miracles than any magician and accompanied by the charismatic gifts bestowed by the Holy Ghost upon the Christian saints, is grounded not in an attitude of selfishness, but in the Christian notion of unselfish love, *agape,* underpinned and suffused by the undemanding, humble attitude summarised by Christ's dictum "Thy will be done". Nor does the Christian saint work his miracles through spirit helpers or by becoming possessed by demons in the manner of the shaman or the psychic – on the contrary he opposes and fights the spirits and demons, who often are reported to taunt and torment him terribly in return.

1896 On magic in the Middle Ages, see [Thor23], [Pete78], [Kiec89], and [Flin91]. Cf. also [Alve62], [Barb63], [Aune80], [Lais41], and [Rude95] p. 20 et seq. The projected six-volume *History of Witchcraft and Magic in Europe,* edited by Bengt Ankarloo and Stuart Clark, will cover the history of magic from Antiquity up to modern times, summing up the extraordinary amount of research that has gone into this area during the latest decades, as witnessed also by the huge collections of research papers made by Levack, *Articles on Witchcraft, Magic, and Demonology. A Twelve Volume Anthology of Scholarly Articles* and *Witchcraft, Magic, and Demonology. New Perspectives* (in six volumes).

1897 [Alki74]

1898 See [Hans86], [Hans78], [Eamo83], [Pete82], and [Kiec89] p. 100 et seqq. Cf. also [Newm89], [Thor23], and [Eamo94].

1899 See [Thor23] vol. II p. 279 et seqq.

Arabic philosophers related to each other and interacted still largely remains obscure, but together they now loomed up as a terrible threat to Western Christianity, causing widespread sentiments of anxiety and alarm both amongst common men and in the minds of leading theologians and Churchmen. We earlier touched upon Voegelin's distinction between the noetic and the pneumatic theophanies, which some are inclined to understand as compatible and supplementary, others not. In the wake of the massive influx of ideas into the West from abroad during the 12th-14th centuries, we can follow the growth of a dialectical pathologisation and gnosticisation of both the noetic and the pneumatic strains of spirituality, which now, it appears, tended to grow increasingly strange and outré through a penchant for undiscerning hyperbole and radicalisation. It is as though the resuscitation of the dialectic *art pour l'art* of the ancient Sophists threatened to replace the serious quest for truth – personified by the efforts of St. Thomas and St. Bonaventure – with dazzling performances of the stage magic of idea mongering, logomachic overstatement, rhetorical cleverness, and enthusiast frenzy, frequently sharpening the standpoints until they become absurd and unbelievable. The ensuing noopathologies of Averroist monopsychism, Alexandrist naturalism, Neoplatonising pantheism, Scotist hyper-realism, and the counterpoint of Ockham's nominalist destruction of Platonism all betray the same Western proclivity for the extreme, as do the great enthusiastic pneumapathologies of the Cathars, Amalricians, the Brethren of the Free Spirit, the Joachitic millenarians, and the Franciscan spiritual zealots. The dialectical oscillations these pathologies put in motion have still not abated.

3.3.6.1 Ockham's Razor and Its Aftermath

> *Like Macbeth, Western man made an evil decision, which has become the efficient and final cause of other evil decisions. Have we forgotten our encounter with the witches on the heath? It occurred in the late fourteenth century, and what the witches said to the protagonist of this drama was that man could realize himself more fully if he would only abandon his belief in the existence of transcendentals. The powers of darkness were working subtly, as always, and they couched this proposition in the seemingly innocent form of an attack upon universals. The defeat of logical realism in the great medieval debate was the crucial event in the history of Western culture; from this flowed those acts which issue now in modern decadence.*
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> *Richard M. Weaver*[1900]

The crossroads, at which Western thought teetered in the 14th century, rightly emphasised by Weaver, Lindbom[1901], and many others inquirers into the history of European thought as of extraordinary significance to its future course, will also be of particular interest to our present theme. The fourteenth century was an age of great societal disasters and growing doubts, as the path of progress and technical development gingerly embarked upon earlier in the Middle Ages began to show an increasingly grim face, the tails of the proto-Faustian coin – with its exacting attitude to nature, its relentless curiosity about its secrets, and its fondness for seemingly useful, but treacherously ensnaring innovations – proving to be both the introduction of new devices and substances of dubious merit, some – such as the gunpowder and the cannons becoming prominent during the protracted Hundred Years War waged by Christian brethren of different nations between 1337 and 1453 – so loathsome as to be widely assumed to be diabolical in origin,[1902] and increasing environmental problems combined with a rapid growth of population, the apparent upshot of which were agricultural crisis – triggered by bad weather –, famines, economical disasters, revolutionary riots, eruptions of violence against minorities, such as Jews or lepers[1903], and the horrendous catastrophe of the Black Death, which during the

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1900 [Weav84] p. 2 et seq.

1901 See, for example, [Lind95] p. 10 et seqq. and [Lind99] p. 139 et seqq.

1902 See [Eamo83] and [SHHV54] vol. II p. 726 et seqq.

1903 See [Nire96], who challenges the popular 'teleological' view, advocated by, for example, Norman Cohn, that there has been a progressive development of European intolerance, the starting-point of which is variously attributed by different authors to the time of the first crusade in the late 11th century, to the first part of the 14th century, or to some other point in history, and the culmination of which will be the Holocausts and Gulags of our own times. Rather, we should, according to this author, think of a "persecuting discourse" as something certain groups actively choose to pursue at specific times in history in preference to more tolerant discourses in order to "achieve something". Such an interpretation appears to come close to the hermeneutical concept of *historicity, Geschichtlichkeit,* i.e. the thesis

years 1347-1350 killed off more than 40% of the population of Europe and laid waste vast regions, some of which have remained depopulated to this day.[1904] The saga of the crusades had – save for some insignificant later adventures – come to an inglorious end in 1291[1905], when the crusaders finally had been driven off the shores of the Holy Land, a debacle upon which followed the disbandment of the order of the Templars in 1307 by the French king Philippe le Bel, accompanied by the most egregious and outrageous suspicions and accusations.[1906] Furthermore, the famous bull *Unam sanctam,* promulgated by pope Boniface VIII in 1302, confidently proclaiming papal authority and the pre-eminence of the Roman Catholic Church, was already in the following year *de facto* nullified by the scandalous kidnapping of the Roman pontiff in Anagni by a group of mercenaries headed by the French minister Guillaume de Nogaret, a minion of Philippe le Bel also playing a prominent rôle in the Templar scandal, and, although Boniface was soon rescued, he expired but a few weeks later, broken and disgraced by the maltreatment and ignominy he had suffered. In 1309, the downfall of papal authority was to culminate in the onset of the dispiriting and humiliating Babylonian captivity of the popes in Avignon, upon which ensued the as demoralising period of the Great Schism with two and, at times, even three popes that laid claim to the tiara. In the 14th century also began the Renaissance, which was founded on a radical reappraisal of history and the propagation of a view of the Christian era as a dark period of decline from the heights attained in the glorious past of ancient paganism. Beyond peradventure of a doubt, Christendom had not met with such rueful misfortunes and calamities since the onslaught of Islam in the 7th and 8th centuries.

In response to the theologically parlous influence of all the simmering neo-pagan or heretical ideas of Aristotelianism, Neoplatonism, Gnosticism, and the Hermetic-occult 'sciences' of astrology, alchemy, and magic, Étienne Tempier, the archbishop of Paris, on March 7, 1277, issued the famous bull that, through the 219 culpable theological and philosophical errors it listed, came to provide the fillip for a consequential re-orientation of philosophy towards voluntarism and a view of this world as wholly contingent.[1907] The effects of this re-orientation, which, in turn, helped to foster the development of experimental science and to undermine the authority of both Aristotelianism *per se* and the deductive Aristotelian view of *scientia* (knowledge), can be clearly perceived in the teachings of John Duns Scotus and even more so in those of his pupil William of Ockham, the "venerabilis inceptor", occasionally also referred to as "the first Protestant" because of his general abrasiveness and antipapal opinions. Scotus became famous primarily for his appetency for obscure

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that man, albeit being conditioned by history, is not pre-determined by it, but transcends history by being able to assess it, take a stand towards it, and choose his way amongst the different possibilities at hand (see [Lübc88] p. 231 et seq.).

Whatever the value of such a perspective in this context, it still seems incomprehensible how, at least nominally, Christian men could indulge in such outrageous and lamentable "persecuting discourse" and in such appalling bouts of mob violence, although we should add that the Church and the Holy See certainly did not sanction these misdeeds and that in many recorded cases bishops and priests by all means and at the peril of their own lives tried to save the victims of the persecutions from their frenzied oppressors, who typically consisted of a riffraff of illiterate scoundrels, ruffians, and criminals whose Christianity will, at best, have been a superficial varnish destitute of any meaningful content. From a Christian point of view, these sad episodes will remind us that the demonic forces that were let loose in the Gulags and Holocausts of our own times through men, who, having given up Christianity and indeed all religion and piety, made their hearts the conduit for these wicked forces, cannot be controlled, let alone exorcised even in a principally Christian society, but that in such a society the borderline between the *civitas Dei* and the *civitas diaboli* will, as pointed out by St. Augustine, always cross right through the Church itself – and at times certainly also right through the heart of the individual *viator.*

[1904] See [Gimp77] p. 75 et seqq. and p. 199 et seqq., [Zieg69], [Gott83], [Plat96], and [Cant01].

[1905] On the history of the crusades, see [Runc65] and [Sett55]. As much harped upon by the foes of Christendom, the saga of the crusades was not only a chivalrous romance of glorious Christian victories over the gentiles, but, like so many wars, occasionally degenerated into a horror story of incompetent leadership, unnecessary bloodshed, pillage driven by a greed for booty rather than the zeal for the Christian faith, and all the outrages and excesses that occur when men make war. As we have seen, it also brought to the West some highly problematical detritus of the Islamic theological, philosophical, and scientific-occult activities and controversies, thereby inspiring heresies and intellectual derailments that would develop in the most eventful ways. For one thing, the infamous Fourth Crusade, getting out of hand already at the start and ending up in the ignominious sack of Constantinople in 1204, more than anything else estranged the Greek Orthodox Church from Western Christianity and, to boot, helped to pave the way for the Saracen conquest of what remained of Greek Christianity (see [QM97]).

[1906] See [Barb78], [Part87], and [Burm90], whose differing verdicts on the likelihood of the guilt or innocence of the Templars only reflect the very divided opinions of the scholarly world on this great historical enigma.

[1907] The Church never officially sanctioned this decree, which was revoked in 1325. Notably, listing about twenty theses derived from the writings of St. Thomas, whose outlook Tempier apparently viewed as too much influenced by Aristotelianism and Averroism, it was strongly opposed by the Dominicans, whereas its influence on Franciscan philosophers, such as Duns Scotus and Ockham, seems all the more substantial. Cf. [Olso82] vol. I p. 194 et seqq. and [Gran96] p. 70 et seqq. Pierre Duhem, in his monumental *Le Système du monde,* proclaimed the issuance of Tempier's decree the birthday of modern science.

subtlety, rendering him the dubious honorific epithet of *doctor subtilis,* and for his purportedly somewhat outré form of *realism,* according to which not only the "natural kinds" of things distinguished by the *distinctio realis* – in contrast to the arbitrary mental constructs arrived at through the *distinctio rationalis* – are "real", but any conceivable concepts having a ground in the nature of things and being distinguishable through the famous *distinctio formalis ex natura rei* – such as, for example, the different faculties of the soul – are to be regarded as "real", as *formalitates* or *gradus metaphysici* of the thing itself.[1908] The Scotist subtlety and conceptual realism were radically reversed by Ockham, the most illustrious Scholastic advocate of *nominalism* (or, more correctly, *terminism)* and the proverbial originator of the principle of simplicity or thought-economy as well as the founder of the school of *via moderna.*[1909]

According to William of Ockham, only individual things are to be regarded as genuinely, objectively real, whereas *species* and *genera* are to be understood as purely mental-subjective constructs, *terms, signs,* or *concepts,* with no real existence or fundament outside the individual mind.[1910] By the same token, he abolished the *universalia ante res,* the creative prototypes in the mind of God[1911], as well as St. Augustine's *rationes seminales,* the 'germs' of divine wisdom embedded in the creation, thus undermining the Christian-Platonic conception of Christ as the Logos, the divine mind maintaining in itself the master plan, i.e. the *universalia ante res,* according to which the world has been created and of which man can – albeit in this world only through a glass, darkly – conceive by virtue of having been created in God's image. In this wise, the Ockhamist God tended to become a *Deus absconditus,* increasingly detached from man and the world, albeit willing the world and the moral order into existence by some caprice of His, and nature, likewise, to became occult, secret, and foreign, similar to a clock wound up by God, rather than luminous, symbolic, meaningful, and permeated by the presence of the Divine Spirit.

This development is not unrelated to the grand split between intellectuality and spirituality that took place at this time – that is to say between, on the one hand, the pursuits of theology, philosophy, and "science" eagerly engaged in by the intellectualist adherents of the *via moderna* and, on the other, the increasingly emotional and private mysticism characteristic of the *devotio moderna.*[1912] Up to St. Thomas and St. Bonaventure, some form of ascetic-mystical practice had been an integral part of the life of most of the great Christian theologians and philosophers and key to their authority as teachers of the Church, but after them mystical practice and mystical theology became increasingly rare pursuits amongst leading Christian intellectuals.[1913] In particular, the Reformation brought about a major decline in spiritual-mystical practice and insight, in which none of the leading, militantly dogmatomachic and intellectualistic Reformers can be said to have excelled, thereby leaving the door open to the various derailed forms of mystical spirituality, not seldom of an enthusiast, gnostic, or occultist hue, that came to haunt and fragment the Protestant world. The upshot

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[1908] Additionally, Duns Scotus' 1) emphasis on the individual things as exemplified by his concept of *haecceitas* (thisness or individuality), 2) accentuation of the will as superior to the intellect (and thus of sin as a perversion of the will rather than as a lack of insight as St. Thomas Aquinas had held), and 3) notion of goodness as based in God's will *(perdeitas boni)* rather than in itself or in its own rationality *(perseitas boni)* turned out to be of great importance for the future. For an excellent overview of the medieval debate on the reality of the universals, see [Klim00].

[1909] See [Leff75]. Befittingly, the originator of the principle of "thought-economy" was also an ardent adherent of the poverty-worshipping zealot party of the Franciscans. [Blum99b] p. 137 et seqq. interprets nominalism as a kind of neo-Gnosticism, pointing out how its voluntarist emphasis on the omnipotence and transcendence of God ("theologischer Absolutismus") undermines the rationality and providential character of the cosmos, makes the order of the creation look arbitrary and unadjusted to man's needs, and removes God from the cosmos by making Him an impersonal, foreign, and possibly inconsiderate *deus absconditus.* Id. op. p. 162 et seqq. also pinpoints some fundamental affinities – perceived already by the Church Fathers and later by, among others, Leibniz (who strikingly remarked, "la volonté sans raison seroit le hazard des Epicuriens") – between the sensibilities of ancient Gnosticism and the Democritean-Epicurean atomism to be revived by the nominalists of the *via moderna.*

[1910] See [Gils99] p. 49 et seqq. Strictly speaking, Ockham's *terminism,* i.e. the view that universals are but mental constructs or *terms,* should be distinguished from both the *nominalism* of, for example, Roscellinus, who held that universals were just names, *nomina,* and the *conceptualist* standpoint, according to which we cannot know whether the mental-ideal *concepts* we call universals correspond to something real that exists outside us.

[1911] Although Ockham denied the reality of the universals, he did, however, acknowledge the existence of ideas of particulars in the mind of God. See [GB37] p. 576.

[1912] Cf. [McIn98] p. 62 et seqq. and [Voeg96] p. 113 et seq.

[1913] There are of course a few notable exceptions, such as Meister Eckhart or Pascal, but the problematic orthodoxy of these great mystics by necessity limited their authority as theologians. Many of the great Catholic saints were of course also great mystics, but they can hardly be said to have been very influential on the intellectual life of Christendom outside the domain of mystical theology.

of this decoupling of the dianoetic quest from religious experience was twofold: Firstly, spirituality, albeit still capable of producing mystics of great holiness, grew increasingly private, emotional, and feminised, and, as a consequence, tended to become theologically indifferent, undiscerning, or heterodox, as rational explication, theological clarification, and critical-dogmatic discernment were pushed aside, often being looked upon with suspicion as a lowly, unnecessary, or even impious travail unworthy of the true Christian saint or mystic immersed in the private revelations, mystical insights and experiences, and spells of bliss given to him during his spiritual quest. Secondly, the intellectual life, shorn of an experiential basis in the life of the spirit, which arguably will be of crucial importance for a proper understanding and appreciation of central Christian mysteries, such as the doctrines of the Holy Trinity, the Logos, and the Holy Communion, tended to transmute into a kind of free-wheeling immanent rationality, a playing-ground for barren and increasingly heterodox, sophistic-scientific bouts and a lopsided, ideologising, cantankerous nominalism largely closed to the dimensions of reality that in the Christian – and indeed in every religious – conception of the world are the ontologically prior ones.[1914]

Although both Ockham's outlook and his underlying motives will in many respects be reminiscent of the responses to the Arabian Platonic-Aristotelian philosophers' hubris framed by the orthodox Sunni theologians, such as al-Ashari's atomist occasionalism and al-Ghazzali's sceptical attack on the philosophers'

[1914] [Buck87] argues that the separation of religious experience and Christology from apologetics, which now instead was grounded in a natural theology underpinned by secular philosophy and science – thereby in effect giving rise to the "secular theology" discussed in [Funk86] and aptly named "theism" by Cudworth –, is also largely at the root of the growth of atheism – the natural antithesis of this theoretical theism – in the West, as the existence of God then came to appear increasingly inferential, a corollary of more or less well-argued and credible rational proofs of His existence – proofs, besides, largely culled from Stoic and other ancient pagan sources, such as Cicero's *De natura deorum,* and, thus, retaining an impersonal, deistic character imparted to them by their lineage, but strangely unfit for the Christian personal, living God. Clad in the garb of natural theology, these proofs could be freely defended, scrutinised, questioned, or even refuted in a theoretical-intellectual joust, which largely, though perhaps not exclusively, seems to have originated with the apologists themselves, be it as a reaction to irreligious sentiments still in the early stages of gestation, the inchoate secularist tendencies of the late Middle Ages and the Renaissance *Zeitgeist* (cf. [Febv42], [Kris68], [Hunt90], and [Woot92]), as a rhetorical exercise against an imaginary enemy, used as a topos in the fratricidal controversies between the Christian adherents of Aristotelian, Cartesian, and Malebranchist philosophy (see [Kors90]), or as a pretext for foisting into the Christian religion *prisca theologia* and other pagan ideas that fascinated the apologists (cf. [Walk72] p. 132 et seqq.). As shown by the growing precariousness of these "proofs" during the centuries to come, in particular as developed in the "universal mathematics" and "universal mechanics" of Descartes and Newton, they, whatever their intrinsic validity as arguments may be, were not impregnable to rhetoric attacks fuelled by the vehement anticlerical or anti-religious sentiments that later became prominent (cf. [Olso82] vol. II p. 87 et seqq.). The perilous reliance on rationalist philosophy and naturalist science to ground religion outside itself, "the self-alienation of religion itself", can perhaps also be construed as a reaction to the early modern thrust towards fideism, which, in turn, had a complex background in nominalist scepticism and Renaissance neo-Pyrrhonism, or as another swing of the pendulum from the foregoing spell of over-confidence in reason meeting the eye both in the obvious arbitrariness of the self-confident proclamations made by the cataract of different Protestant sects, enthusiasts, and soi-disant theologians as well as in various scholastic and hyperrationalist constructions, such as, for instance, the natural theology of Raymond of Sebond examined by Montaigne, the most famous of the neo-Pyrrhonists. [Kors90] largely endorses and elaborates Buckley's thesis, whereas some reservations about it are put forth in [Lash96] p. 132 et seqq. Somewhat similarly, [Turn86] p. xiii concludes that "in trying to adapt their religious beliefs to socio-economic change, to new moral challenges, to novel problems of knowledge, to the tightening standards of science, the defenders of God slowly strangled him". Likewise, [Kley84] derives the French Revolution and the subsequent division between liberals and conservatives from the Jansenist controversy that raged in France during the larger part of the 18th century, whereas [Cann60] argues that Victorian natural theology provoked and promoted its own Darwinist antithesis. Additionally, [Whit68] p. 100 et seqq. construes the emergence of natural theology in the 13th century as a Christian response to the anti-cosmism of Catharism. For some interesting remarks on such "gravedigger theories", see [Gay98] p. 16.

In this context, I should like to point out that, although ideas admittedly are important and have consequences, the Hegelian view that history boils down to a dialectic unfolding of the logic inherent in concepts and theories and is to be studied as a kind of Galilean-Newtonian dynamics of ideas seems to the present author as questionable as the Marxian materialistic reification of this idealistic dialectics. Firstly, Voegelin's deep insight that "the substance of history is to be found on the level of experiences, not on the level of ideas" ([Voeg87] p. 125) and his criticism of ideas as "liable to deform the truth of the experiences and their symbolization" (see [Voeg96] p. 78) should give us pause. Somewhat in the same vein as Voegelin, Owen Barfield in [Barf88] and various other works developed his theory of an "evolution of consciousness" through abrupt gestalt shifts in our way of experiencing the world; cf. also the Owen Barfield web site http://www.owenbarfield.com and [Talb95] p. 385 et seqq. for a summary of Barfield's ideas. Secondly, the superficiality, vapidity, and utter pedestrianism of Hegelian, Marxian, Darwinist, and other such modern schematisms become particularly evident when these barren abstractions are compared to the profundity of the traditional Jewish-Christian eschatological conception of history, in which the vagaries of the history of the nations and the struggles of ideas in the present world are intertwined in subtle and intriguing ways with the grander drama of the struggles in the Heavens. Indeed, we have already repeatedly argued that the former schemes are but immanentisations of the latter. Thus, the aforementioned explanations of the origins of unbelief, albeit not devoid of truth, in the end appear unsatisfactory and inadequate, unduly depreciating the enormity and demonism of the modern gnostic rebellion against God by making it the upshot of some historical and intellectual contingencies, as though we were here dealing with some kind of chemical process rather than the struggle between the powers of darkness and powers of light over man's soul.

audacious declarations about God and the cosmos, the thought of the Ockhamist school soon came to unfold in a very different direction, becoming not the bulwark of religious orthodoxy against the vagaries of philosophical speculation, but a tremendous fomenter of subjectivism, scepticism, naturalism, reductionism, secularism, and the deistic-atheistic removal of the divine presence from a universe increasingly conceived of as a mechanical clockwork. The causes of this unexpected turn will be both complex and hard to pinpoint with any confidence, although it has been suggested that the introduction in scholastic thought of a distinction between the three categories of the *natural,* the *praeternatural,* and the *supernatural,* which, arguably owing much to Aristotle's commentators and perhaps also something to the Stagirite himself, purportedly differs markedly from the pervasive supernaturalism implicit in, for example, St. Augustine's conception of everything in this world as ultimately authored by God or the Asharite doctrine of God's re-creation of the world at every moment, is one factor that might have helped to pave the way for the gradual occlusion of the supernatural by the natural.[1915]

Another such factor will be Ockham's famous "razor"– usually cited as "entia non sunt multiplicanda praeter necessitatem", entities are not to be unduly multiplied, although this formula reportedly does not appear anywhere in Ockham's corpus of writings as it has come down to us. Albeit originally provoked by a, perhaps, basically sound reaction against the excessive rationalist self-confidence and proclivity for quibbling niceties of some of the Schoolmen and still widely adduced as a fundamental principle of scientific ratiocination, this principle of "thought-economy" indeed seems to be a both generally vague and in many ways objectionable, not to say obviously fallacious by-law. For, firstly, it seems to presuppose a very slapdash view of theories – perhaps fostered by the at times hair-splitting climate of scholastic discussion – not as earnest attempts to find out the truth about reality, but as disposable, purely subjective tools, which philosophers and scientists may play around with and choose between more or less arbitrarily according to their own whims and dispositions.[1916] Secondly, by making *simplicity* rather than *truth* the touchstone of what counts it strongly suggests, or perhaps even presumes, the nihilistic conclusion that no objective reality exists or can be accessed against which to measure the validity of our concepts and theories – "nothing is true, everything is permitted". Thirdly, it seems to imply an unfair pre-commitment to reductionism, positivism, monism, naturalism, and similar stances, thereby unduly slanting the rules in favour of a certain metaphysical

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[1915] In Scholastic terminology, *natural* events have well-known causes and occur "naturally" in the usual course of things pursuant to God's ordinations through His *potentia ordinata,* i.e. his ordained power as laid down in the regular course of nature, which is the result of His general providence, *providentia generalis,* concerning man and the other created beings. In contrast, *supernatural* events *(miracula)* are brought about by God's extraordinary intervention in the world as made possible by His *potentia absoluta* (absolute power) and constitute proof of His fatherly concern for His creatures through special providence, *providentia specialis.* Finally, *praeternatural* events *(mirabilia)* are unusual phenomena not attributable to God's own intervention, but caused by angels or demons, by artificial means, such as conjuring tricks or technical equipment, or by unknown or occult causes. Despite its purported Aristotelian origin, this distinction also tallies well with some Biblical passages (such as *Ex. 8:19* and *Act. Ap. 8:9-24),* where divine intervention is contrasted with magical mirabilia. See [Hans78], [Hans86], [Eamo94] p. 63, [Kiec89] p. 100 et seqq., [Funk86] p. 124 et seqq., [Ward87], and [Ward92].

St. Augustine, who, by the way, took an eager interest in psychical phenomena (see [Mont26], [Creh76], and [Dodd71] p. 205 et seqq.), submitted that strictly speaking there was really only one great miracle, viz. God's creation of the world, but that, alternatively, all events may be regarded as miraculous by virtue of their ultimate procession from God, although men generally do not recognise the miraculous character of what they are accustomed to, but only of more unusual events caused by the hidden *rationes seminales* that God had implanted into His creation from the beginning. In contrast, the Scholastics made miracles something exceptional by their tripartition of events in *natural, supernatural,* and *praeternatural* and the related distinction between the *potentia ordinata* and *potentia absoluta,* introduced by Alexander of Hales, the first of the Schoolmen showing an intimate familiarity with the Aristotelian corpus and its Arab commentators. It has been argued that the underlying scholastic dichotomy between a realm of pure nature, susceptible to natural reason and scientific exploration, and a realm of supernatural grace only to be approached through faith, revelation, and theological methods – carried to its extremes in the Averroist tenet of the double truth, which in turn reflects the *zahir-batin* dichotomy of the Moslem batinists – played a decisive rôle in the gradual supersession of revelation by nature, of supernatural experience by natural exploration, of a cosmos, where the transcendental and divine pervades everything, by the modern conception of the world as a playground for entirely immanent forces. See [Luba65], [Bore98], [Scha68a], [Voeg96] p. 108 et seqq., and [Clou91] p. 82 et seqq.

[1916] This view, in turn, seems to be a consequence of the growth in popularity of Aristotelian sensualism – as summed up by the formula "nihil est in intellectu quod non fuerit in sensu" – at the expense of the Augustinian theory of divine illumination of the mind – which, in turn, will largely be equivalent to the Platonic theory of *methexis,* participation, in the divine ideas – as the basis for a realistic conception of the world, at least when a purely psychological interpretation was settled on of Aristotle's enigmatic pronouncements about *νοῦς* or *intellectus* in *De Anima III.v,* momentously commented upon by Alexander of Aphrodisias, who was the one making the famous distinction between *νοῦς ποιητικός* and *νοῦς παθητικός*, *intellectus agens* and *intellectus possibilis*, of which the former was transformed by the Islamic Neoplatonists into the last of the angelic, planet-moving intelligences that successively emanate from each other and, in the last instance, from the World Soul, the World Intellect, and the One, and heatedly debated and speculated upon by the Schoolmen in the High Middle Ages (see [Merl63], [Davi92a], [Bren95], [Grab36], and [Corb93] p. 153 et seqq.).

viewpoint. Consequently, it cannot, as often is done, be regarded as an innocent, neutral directive suitable for the arbitration of philosophical, religious, or scientific debates. On the contrary, we must ask: Of what avail is this principle of preferring the simple explanation to the complex one, if the complex theory in the end turns out to be true and the simple one false? Then, we have indeed been utterly deceived by this wishy-washy concept of "thought-economy", founded in arbitrariness and illogicality!

In default of a clearly discernible metaphysical reality, a *mundus intelligibilis,* behind the *mundus sensibilis,* nominalism, if taken seriously, tends to render the world a meaningless, incomprehensible ruck of particulars or, in its ultimate sensualist corollary, the dizzying fireworks of sense impressions, transforming the ordered universe into a multiverse of individual conceptual and sense-impressionistic worlds. To Ockham himself, whose philosophy largely sprang from a strong sense for the absolute freedom and inscrutability of God against the vainglorious Scholastic attempt to subject Him to meticulous examination, on the whole consistent with the intentions of Tempier's 1277 decree, the stark cleavage of reason and faith and the negation of the validity of man's conception of the world were balanced by his own acceptance of the proofs of God's existence and to all appearances sincere espousal of the Christian faith, but to many others – and increasingly so as time went on – the outcome of listening to the dulcet Ockhamist siren song was a relapse into the perplexities of Sophistic philodoxy, an opening of the door to the arbitrary re-interpretation of the world according to one's own whims and preferences, and a decline in the faith in the reasonability of the serious search for the truth about it. The lid thus removed from Pandora's box, out flew scepticism, subjectivism, reductionism, monism, materialism, constructivism, logicism, sensualism, and all the other well-know isms characteristic of modernity, all bearing witness to the modern obsession with Ockhamist thought-economical flattening.[1917] The long-ranging tendency in Western thought towards one-dimensionality, reductionism, and the folding of hierarchies, starting with the Scholastic revival of Aristotelianism in the High Middle Ages and strongly gaining momentum through Ockhamism, can be seen in many areas, including:

- *theology,* where the flattening tendency becomes particularly apparent in the various forms of rationalist folding of the Christian Trinity into a monistic and increasingly impersonal, typically deistic or pantheistic, conception of the Godhead, soon to be followed by the corollary of the radical atheist abolition of God
- *ethics,* where Christian-Platonic value objectivism was replaced by immanentist value subjectivism and relativism, as though the belief in immanentist-naturalist "laws of nature" automatically abrogated the transcendental-ethical "laws of God"
- *ontology,* where the idea of the cosmos as layered into multiple levels of being, underpinned by the notion of a *materia spiritualis* ('fine matter') as an intermediate between matter and the immaterial, was first simplified into the basically dualist scheme of Aristotelian hylomorphism adopted by many Aristotelian Schoolmen, including St. Thomas, later to be further sharpened into Cartesian dualism, which, largely by virtue of its obscurity on the crucial question of the connection between the spiritual and the material and its image of the spiritual as a mere 'ghost in the machine', lent itself to all kinds of monistic and materialistic radicalisations and simplifications
- *psychology,* where the doctrine of the spiritual body as the vehicle of the soul – to which the aforementioned theory of *materia spiritualis* of course was ancillary – was somewhat weakened already by the adoption of the rather clearly dualistic Thomistic-Aristotelian notion of the rational soul – in which, besides, were included also the sensitive and vegetative principles or 'souls' – as the substantial form of the body[1918] and later entirely demolished

[1917] For example, [Pilt78] p. 234 mentions four Ockhamists, who radicalised the Ockhamist doctrine in theologically doubtful ways: Adam Woodham denied the validity of the proofs for God's existence, Robert Holcot claimed that the doctrine of the Trinity was incompatible with logic, and Jean de Mirecourt and Nicolas d'Autrecourt advocated radical scepticism. It was also in the Ockhamist School that some of the first steps towards an empirical-experimental science were taken (see e.g. [Butt60] and [Pede77]).

[1918] This doctrine, which was made an article of faith in 1312 by the council of Vienne, tended, at least if narrowly interpreted, to render the status of non-corporeal beings, such as angels and demons quite precarious. Thus, St. Thomas, holding the *principium individuationis* to be matter (rather than matter and form as St. Bonaventure and others held) was awkwardly impelled to assert that each such spiritual being constitutes its own species – a rather unsatisfactory theory, actually also to be condemned by Tempier in 1277. Additionally, the hylomorphic conception of man, taken at face value, makes the immortality of the rational soul seem doubtful, as it indeed also was to Aristotle himself. In particular this will be the case, if, contrary to St. Thomas' view, one denies that the *anima intellectiva,* the rational soul, which is the form of the human body, is a *forma subsistens* (or *forma immaterialis),* an immaterial form also being a substance capable of sub-

by the nullibist Cartesian notion of the soul as an unextended *res cogitans*, which in the end would inevitably be made to evaporate altogether, either by being flatly denied, as is done in eliminative materialism, or by being made into a bogus epiphenomenon of the brain

- *natural philosophy,* where the distinction between the *natural, supernatural,* and *praeternatural* gradually eroded, the demesne of the latter two categories diminishing, until only natural events remain universally accepted
- *causality,* where of the four-fold causes of the Aristotelian model of explanation – i.e. the *causa materialis, causa efficiens, causa finalis,* and *causa formalis* – the primary *causa finalis* and *causa formalis* were subject to growing criticism, doubt, and negligence, until 'cause' became more or less synonymous with the secondary 'effective cause', *causa efficiens,* and nature, thus, came to be viewed as a material machine shorn of design, form, purpose, and meaning, ruled by rigid "laws of nature"[1919]
- *hermeneutics,* where the four-fold schema of interpretation (i.e. the famous *quadriga* of the historical, tropological, allegorical, and anagogic senses) was to be replaced by the one-dimensional, literalist-grammatical so-called "critical" methods of the humanists and the Biblical scholars of the school of "higher criticism"
- *gnosiology,* where the cognitive models based on the Platonic theory of *anamnesis,* the Augustinian theory of *divine illumination,* the Aristotelian/Neoplatonic theories of *intellectus agens,* and various *innatist* schemes, had to give way first to more trivial, naturalist accounts of abstraction, then to pure sensualism and empiricism, which implausibly made the human soul a *tabula rasa,* or to scepticism, and finally to the subjectivist constructivism of Kant and his various latter-day followers[1920]
- *cosmology* where the hierarchical, closed, geocentric worldview with its bipartition of the world into a sublunary portion composed of the four elements and a superlunary one made up of the revolving quintessential celestial spheres, populated by the heavenly hosts and enclosed by the Empyrean abode of God, was to give way to the modern heliocentric worldview with its uniform, infinite space, originally often pantheistically conceived of as divine in nature, as though the Divinity, through the abolition of His Empyrean abode, had been homogenised all over space and now penetrated every nook and cranny of it, but over time becoming increasingly disenchanted and losing all reference to value, purpose, harmony, and divinity[1921]

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sisting and acting on its own account, rather than a *forma non-subsistens* (or *forma materialis),* a material form that depends on matter for its existence. The decision of Vienne was primarily directed against the errors of the Franciscan spiritual Peter Olivi, who taught that the sensitive part of the soul (rather than the rational soul *per se)* was the form of the body and, more generally, also against the trichotomism of the enthusiasts and pantheists. See [Pasn99]. Cf. also [Poor78] vol. II p. 97 et seqq., who makes this decision a major turning point in Western intellectual history.

[1919] See [Dijk86].

[1920] See [Burt99].

[1921] See [Koyr58] and [Guar98b]. [Koyr43] aptly refers to this change as "the destruction of the Cosmos" and argues that modern science resulted from the unification of astronomy and physics, the superlunary laws of the Heavens and the sublunary laws of the Earth, through the "geometrization of space", by which the mathematical methods of astronomy were applied also to the sublunary world. [Tuve82] p. 76 et seqq. ascribes the homogenisation of the universe first ventured by Cusanus to Hermetic influences, whereas [Taub91] p. 88 construes it as the corollary of Joachim of Fiore's drawing down Heaven to Earth and [Funk86] p. 63 et seqq. derives it from Cusanus' negative theology with its paradoxical conception of God as *coincidentia oppositorum,* which, it is argued, led to an equally paradoxical view of the universe – construed as God's self-expression and as an analogy or image of the divine – as "neither finite, nor infinite, neither discrete, nor discontinuous, neither at rest, nor absolutely in motion". In the works of Cusanus, whose seminal ideas about the *docta ignorantia,* learned ignorance, and the *coincidentia oppositorum,* the coincidence of opposites in God, were revealed to him in a kind of visionary-ecstatic experience he had in 1438 during the boat voyage that brought the Byzantine Emperor, Gemisthos Plethon, Bessarion, and numerous other Orthodox prelates from Constantinople to the Council at Ferrara/Florence, historians have also discerned the embryos of many of the founding ideas and theories of modernity, such as Paracelsus' emphasis of the importance of empirical measurement (in particular weighing), Galileo's appreciation of mathematics, Bruno's pantheism, Leibniz' and Newton's infinitesimal calculus, Lessing's and Semler's ideas about religious tolerance, Hegel's dialectics, Schelling's notion of intellectual intuition, and even Einstein's theory of relativity. Notably, Cusanus also, in league with pope Pius II, worked out a reform proposal for the Catholic Church – never realised as they both died almost simultaneously in 1464 – and struggled to overcome confessional and other divisions, even taking a positive interest

- *biology,* where the great chain of being was eventually to be superseded by the notion of a uniformitarian evolution

Although admittedly the speculative moment inherent in the hierarchical approach of the *via antiqua* may easily degenerate into free-wheeling arbitrariness, credulity, rash conclusion, or excessive formalism, as it at times actually also did, at least with its lesser proponents, the abolishment of this approach by the votaries of *via moderna* bred superficiality and absurdity of an heretofore unknown enormity, making nought not only of man's experiences, but of man himself, the cosmos, and God. From the meaningful, symbolic universe ruled by the final causes grounded in the graceful and providential mind of a God, nominalism blazed, if not exactly a straight, nor an exceedingly serpentine road to the modern disenchanted cosmos, ruled only by the unpropitious idols of randomness and necessity, strangely believed capable of conjuring up our well-ordered experiential world, conceived of as sheer appearances, by some unexplainable whim, much like that of some larger-than-life madcap Faustian prestidigitator.

The breakdown in the late Middle Ages of the Scholastic attempts to create a grand synthesis of theology and Aristotelian philosophy, becoming manifest in the unedifying quibbles between the different schools, of which the sceptical and freethinking Ockhamists seemed to get the upper hand in this period, caused growing doubts about the feasibility of harmonising faith and reason at all and, thus, also became instrumental in the subsequent separation of theology, philosophy, and science.[1922] This decline in spirits was of course also much amplified by the aforementioned civilisational disasters of the 14th century and the many by then all too well-known problems and pitfalls incidental to the attempt to build a *civitas Christiana* on earth, as it became increasingly clear that Christ's kingdom cannot be forced to be of this world, however much man would wish to have it so, and men proved to be just as corrupt and recalcitrant to the Christian reform of heart as St. Augustine had noted at the very outset of this attempt. That the subsequent attempts to abolish the *civitas Christiana* would in due time prove the society 'liberated' from Christianity to be a hellish nightmare, for which more apt appellations than Antichrist and *civitas diaboli* hardly can be found, bringing about woes far more pernicious than anything heretofore encountered on earth, still remained for man to discover.

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in Islam and authoring a treatise, *Cribratio Alcorani,* where he tried to show that the Koran contained the same truths as the Christian gospels.

[Funk86] also points out that in the animistic, anti-teleological natural philosophy of some Renaissance thinkers, such as Telesio, Cardano, Bruno, and Campanella, Stoic *forces* – a concept based on the age-old theory of magical *sympathy* (cf. [Fowd93a] p. 75 et seqq.) – mediated by some kind of *World Spirit* or *World Soul,* as espoused in Antiquity by, for example, Empedocles, Bolus from Mendes, Posidonius, the Hermetica, and the Neoplatonists, were substituted for Platonic-Aristotelian *forms.* So, all bodies, regardless of whether their current situation are in Heaven or on Earth, try in their own self-interest to preserve the balance between these occult forces – ultimately reducible to attraction and repulsion, heat and cold centred in the Sun and the Earth respectively –, by which they are animated. This sensualistic, materialistic, and dynamistic philosophy of self-preservation, foreshadowing the idea of the "invisible hand of nature", from which evolutionism and Darwinism later emerged, was radically reductionist in tenor and, thus, just like the ancient Atomists and Stoics, favoured a conception of the universe as homogenous. That the notion of the universe as homogeneous was part of the Hermetic-Stoic legacy traded down in Ismaili Shiism, so important for the *Überlieferungsgeschichte* of the (occult) sciences and the Hermeticism fervently pursued by the aforementioned Renaissance thinkers, is stated by [Corb93] p. 127 on the basis of [Mass44] p. 388 et seqq., but seems highly dubious – cf. [Cope95] p. 116 et passim. On the "heliocentrism" – i.e. the belief that the Sun occupies the middle position in heaven, which is to say that it occupies the middle position amongst the "planets" that, just like the Sun, revolve around the Earth – of the Hermetica and the belief in the Sun as the Demiurge, through which the divine powers flow into the sensible cosmos (expressed in *Corp. Herm. XVI;* cf. also *Asclepius 3* and *19),* see [Fowd93a] p. 77 and [Cope95] loc. cit. The Hermetic cosmology may have encouraged Copernicus' heliocentrism – in *De revolutionibus orbium caelestium* he cites Trismegistus' view of the sun as a visible god in a key passage – as well as the prominence given to the cult of the Sun in Bruno's attempted restoration of the Egyptian magical religion; see [Yate64] p. 153 et seqq. et passim. Additionally, the Christian 6th-century Monophysite philosopher John Philoponus' criticisms of the Aristotelian compartmentalisation of the cosmos into a sublunary and superlunary portion – as well as of many other of Aristotle's ideas about, for example, the nature of motion (where Philoponus advocated a kind of impetus theory), the impossibility of vacuum, or the eternity of the world – also made their way into the medieval Scholastic debate via the writings of the Moslem scholar Avempace (see [Lind92] p. 162 and p. 302 et seqq.). During the Renaissance some of Philoponus' writings were translated into Latin and influenced, amongst others, Galileo. Cf. also [Eamo94] p. 156, [Pine53], and [Sali99a]. Other investigations of the history of space are [Jamm93] and [Wert00].

Apparently as a consequence of this homogenisation of the cosmos, the angels and demons of yore were, from Cusanus in the 15th century (see [Pede77] p. 74), slowly supplanted by the supposed inhabitants of the plurality of worlds now assumed to exist out there in space – Swedenborg will have been one of the first who claimed to be in contact with such "aliens". Cf. [Benz78] and [Blum99b] p. 173 et seqq. [Fowd93a] p. 77 interestingly points out that the Hermeticists tended to see the demons as personifications of the sympathetic energies that permeate the universe and control its fate, *heimarmene,* from on high, being emitted from the Sun, the Moon, the planets, and the stars.

[1922] See [Funk86] p. 1 et seqq. et passim.

Already Ockham, having escaped from Avignon and the on-going papal scrutiny of his teachings, vouchsafed to become a resident of the court of the excommunicated emperor Louis the Bavarian, where also other heterodox or antipapal scholars, such as Marsilius of Padua and John of Jandun found refuge, and during the ensuing centuries the royal courts came to provide a mainstay of free-thinking, where secularism, heterodoxy, occultism, and what the historian Amos Funkenstein has called 'secular theology' thrived and grew rankly, not seldom fomented by ambitious or cynical rulers' self-interest and greed for wealth and power, although the full consequences of the bargains struck between the new intellectual élites and the powers that be were to be seen first during the Reformation.[1923] Notably, the arrival of the printing press in the 15th century made for a much-intensified exchange of the philosophical, theological, political, and scientific ideas instrumental in the revolutions and commotions that were to follow within these realms. In addition, the wealth of new and rapidly disseminated information about the world and the mores and religions of foreign peoples flowing from the expansion of the geographical horizons naturally exacerbated the prevalent crisis of thought.[1924]

From this crisis, a renewed interest in ancient pagan thought as well as intense attempts to reform the Christian religion followed. The former interest gave rise both to new efforts to reconcile Christian faith with ancient philosophy and to scepticism about the feasibility of such projects.[1925] Much in the spirit of *devotio moderna,* the mystical-experiential spirituality of the late Middle Ages and early Renaissance, the philosophical focus now shifted towards the mystical Platonic-Hermetic-Kabbalistic veins of thought and away from Aristotelian rationalism, the advocates of which tended either towards irreligion and secularism, as in the Averroist and Alexandrine sects, or towards cantankerous and rigid doctrinairism, as amongst the adepts of the different Scholastic-Aristotelian Schools.[1926] The attempts to create a synthesis of Christian religion and Platonic philosophy – or rather a mystico-eclectic complex of Platonism, Hermeticism, Cabalism, and occultism –, incidentally giving birth also to modern science,[1927] culminated with the Cambridge Platonists, who, as can be seen from Cudworth's, More's, and Glanville's polemics against the great heretics of their times – Hobbes, Spinoza, and Pomponazzi – and against atheism, materialism, disbelief in miracles, enthusiasm, Pyrrhonism, Cartesian nullibism, etc., were also amongst the first to perceive that a major, dangerous shift in European thought was now about to take place through the growth of free-thinking and the ensuing disorientation, reflected, for example, in the frequent hopping of leading intellectuals between different religious persuasions at this time.[1928] Although the Cambridge Platonists tried to combine – Protestant – orthodoxy and the rationalism implicit in all philosophical endeavours, the Christian Platonism they espoused, largely by virtue of its fundamental openness based in the mystical-experiential approach to the divine and its misgivings about the dogmatic petrifaction of spirituality, had all since Clement and Origen been a hotbed for heterodox opinions. For one thing, its record and reputation as a breeder of heresy eventually caused the Catholic

[1923] [Funk86]. Already the medieval court was often a nidus of magic, astrology, and alchemy, on which topics an abundant and learned literature sprang up. See [Eamo94] p. 66 et seqq. and p. 221 et seqq., [CH61] p. 47 et seqq., and [Veen97].

[1924] See [Eise80] and [McLu62].

[1925] Such scepticism does by no means need to be associated with anti-religious sentiments, as is nowadays often assumed. On the contrary, there is an age-old tradition of Jewish, Christian, and Moslem scepticism and fideism, going back to Ecclesiastes, St. Paul, and Tertullian (if not to Christ Himself), and counting amongst its exponents such influential thinkers as Manegold of Lauterbach, St. Peter Damian, Lanfranc, Bernard of Clairvaux, Ockham, Cusanus, (perhaps) Montaigne, Pascal, Jacobi, Kierkegaard, Barth, Shestov, and al-Ghazzali (and indeed Sunni Islamic orthodoxy in general). Emphasising the paradoxicality of faith, as in Tertullian's famous dictum, *credo quia absurdum,* and advocating a fideist point of view, such fideist sceptics have on good grounds questioned the philosophers' and scientists' – and also some theologians' – proud and rash confidence in the capability of the human mind to fathom out all the mysteries of existence. The Protestant polemics against the Scholastic *usus rationis magisterialis* in theology will also partly be an expression of such a sceptical temper.

[1926] Cf. [Sher95] p. 111 et seqq. The great struggle between Aristotelian and Platonic philosophy, ingeniously captured in Raphael's painting of the school in Athens, raged from the middle of the 15th to the end of 17th century, having been brought on the table by the polemical writings of Plethon, George of Trebizond, and Bessarion. Perhaps, we may regard the intellectual history of our civilisation as oscillating between the three poles of Platonic-Stoic mysticism (typically wedded to elements of primitivism and romanticism), Aristotelian-Epicurean rationalism, and Pyrrhonic-Academic scepticism All three varieties can be found in pre-Christian, orthodox as well as heterodox Christian, and in modern, anti-Christian varieties.

[1927] See above p. 319. Most of the 'fathers of science' had close ties to this project, including Copernicus, Kepler, Galileo, Boyle, and Newton (see e.g. [Koyr43] and [Duse99] p. 99 et seqq.). The fascination with mathematics and the "geometrical method" is characteristic of Platonism and Pythagoreanism, as can be seen also in the medieval philosophers of a Platonic bent, such as Thierry of Chartres, Robert Grosseteste, and Roger Bacon.

[1928] Cf. [Mint62] and [Walk72] p. 132 et seqq.

Church to give up its attempts to pacify Platonism and take advantage of it philosophically, as an alternative to Aristotelianism.[1929]

The attempts to reform the Christian religion, which, similarly to the humanist Renaissance and the philosophical revitalisation efforts, took the form of a revisitation of ancient origins, bred a religious fervour and enthusiasm, which, becoming mixed up with all kinds of political agendas and power fights as well as with the strivings of worldly rulers to enrich and empower themselves, came to unfold in extraordinarily vicious and bellicose ways. Albeit instigated by a wish to rejuvenate Christianity by restoring it to its true essence, shorn of the unnecessary or unseemly accretions picked up during the ages, these efforts instead seriously sapped Christianity, put a final end to its unity, splitting it up into a proliferation of warring sects, national churches, and a much weakened Catholic mother Church, and issued in the terrors of religious wars and persecutions so jarringly inconsonant with the Christian gospel of love.

As a result of this derailment, philosophy and theology were transformed into a battlefield of personal opinions and tastes, often vehemently promulgated as absolute truths. Gradually, ideas and opinions came to be regarded as the expressions of the self – a kind of egophany, as Voegelin so aptly called it, by which you show, who you are – and, consequently, something one rather arbitrarily may put on and take off, like a cap or a glove. Thus love of wisdom (philosophy), right doctrine (orthodoxy), and the sincere search for truth was once again destroyed by philodoxy, the chaos of opinions, rash conclusions, freethinking, philosophical systems, and all kinds of isms and doctrines, in short, the relapse into the plight of the 'Sophistic Enlightenment', through which the history of Western thought started its labyrinthine course.

[1929] The chief problem with Platonism – or rather with Neoplatonism, as Platonism will in this context mostly will be synonymous with – from a Christian viewpoint is that it, much more than Aristotelianism, is inherently religious and, thus, tends to encroach dangerously on the realm of Christian doctrine, leading to conflicts on a variety of issues, notably:

i) the nature of God – Christian theism vs. Neoplatonic pantheism with panentheism as a possible, albeit unorthodox, compromise

ii) the character of God – the Christian personalistic conception of God vs. the Platonic abstract conception

iii) the inner structure of the Deity – the Christian Holy Trinity of the Father, Son, and Holy Ghost vs. the Neoplatonic trinity of the *One, Nous,* and *Psyche* – in particular the identification of the Holy Ghost with *Psyche,* the World Soul, is highly problematic (cf. [McGi95] and [Leij98]), although, more oddly, there has also been a marked propensity for Arianism amongst Christian Platonists (see [Walk72] p. 40 et seq. et passim)

iv) the origin and temporality of the cosmos and the living beings – Christian *creatio ex nihilo* vs. Neoplatonic atemporal emanation, informing pre-existent matter

v) the nature of the soul – the Christian creationist doctrine of the soul vs. the Platonic doctrines of a pre-existent soul, anamnesis, and metempsychosis (see [Walk72] p. 110 et seqq., [Henr79] p. 553, and [Manc92]).

Thus, heterodoxy has always been rife amongst Christian Platonists, from Clement, Origen, and Eriugena to Ficino, Pico, Servetus, Patrizi, and Newton, making many of them in the end appear more Platonic than Christian, although it should be emphasised that some of the greatest orthodox teachers of the Church indeed have also been Platonists, including the Cappadocian Fathers, St. Augustine, and St. Bonaventure (see [Iván64]). Indeed, as was pointed out above (see p. 370) the history of Neoplatonism is closely interrelated to that of early Christianity, and, up to the philhellenic apotheosis of the Greeks and denigration of Christianity in the late 18th and early 19th centuries, the debt of the former to the latter was widely recognised as more or less obvious. Although few scholars will subscribe to this view presently, it in fact seems that a good case can be made for a decisive influence of Christian teachings on Plotin and the other Neoplatonists. Notably, Ammonius Sakkas, the teacher of both Plotin and Origen, was a lapsed Christian, and Plotin, albeit very critical of Gnosticism, is oddly silent about Christianity. Cf. [Walk72] p. 81.

3.3.6.2 The Pact – Descartes and the Modern Constitution

> *If we like to fix history in our mind with symbolic events and dates, we may choose the original appearance of Dr. Faustus and the date 1587 as a hypothetical turning point in western culture. For in that year was published the first account of Faust's compact with the devil, an established Power and Device which an enterprising magician like Faust would naturally come to terms with. The bargain that he made then should not be confused with later versions of the tale. The favors Faust was asking for in the sixteenth century were not knowledge and a beautiful woman to love. They were: abundance of food and clothing. Faust also asked for pocket money and, by way of entertainment, he expressed a wish "to fly among the stars".*
>
> *Jacques Barzun*[1930]

The rise of Faustian modernity is closely associated with the name of René Descartes, who is widely considered the most influential and important of the philosophers – or shall we call them "secular theologians"[1931] – of the 17th century and the father of modern secular philosophy and science. Granted that the onset of Cartesianism and its triumph over the Aristotelian school tradition of philosophy and theology inaugurates the modern age, we may even accord a birth date to modernity, as an alternative or supplement to the one suggested by Barzun, to wit November 10 of 1619, for it was on the evening of this day in the small stove-heated room, where he had lodged nearby Ulm in Germany, that Descartes, serving as an officer in Maurice of Nassau's army during the prelude to the Thirty Years' War, had the famous fit of "enthusiasm" and the subsequent dreams and visionary experiences, which inspired him to devote the better part of his remaining life to the development of a mechanistic-mathematical conception of science and knowledge on the basis of the analytical method he had conceived that very evening.[1932] By this rationalist method, moulded on the deductive mathematical-geometrical method of Euclid and the other ancient mathematicians, he wanted to circumvent the slough of scepticism generated by Montaigne, the fideists, and the libertines, finding a fulcrum in the famous formula *cogito, ergo sum,* similarly to the way St. Augustine had vanquished academic scepticism by his formula *si fallor, sum.*

We do not here need to go into at great length how Descartes developed this basic nisus in his own philosophy. His stark "property dualism"[1933], according to which the entire material world, the *res extensa,* constitutes a single substance operating as a large machine, whereas there is a plurality of soul substances, *res cogitantes,* and these two types of substances mysteriously interact through the pineal gland, provided the starting-point for heated disputes amongst his contemporaries and remains a popular object of cavil to this day. In contrast to the Aristotelian-scholastic soul, which also was the *form* of the body, and the widespread notion of some kind of "spiritual body" as an intermediate between body and spirit, Descartes' soul, construed as pure thinking, was unextended and entirely outside space and, thus, also lacked spatial form and position. Consequently, he came to view the body as a kind of machine, working according to entirely mechanistic principles, although the human soul was capable of controlling it by influencing the direction of the motion of corpuscles via the pineal gland. His provocative and, indeed, grotesque view of animals as purely mechanical, soulless automata and man as a machine with a rational soul loosely tacked on met with much incredulity amongst his contemporaries, but was soon to be radicalised by such arrant materialists as

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[1930] [Barz64] p. 19 et seq. Barzun does not seem to have noted that Faust's wishes amount to an affirmative reply to the inducements the devil presented to Christ, as recounted above on p. 353. On Christ and Faust, see also [Braw01] p. 64 et seqq.

[1931] So [Funk86].

[1932] See [Shea88] p. 80.

[1933] *Substance dualism* is the doctrine that only two substances exist – typically soul and matter –, whereas *property dualism* maintains that two *kinds* of substances exist. Insofar as Descartes recognised a plurality of souls, he can also be called a *substance pluralist*. The significance of the term "substance" has been in a flux in modern philosophy all since Descartes, who, by defining a substance as a thing, which exists without needing anything else for its existence, subtly broke with the traditional Aristotelian-Scholastic usage, according to which *substantia prima* signifies individually existing things (understood as "hylomorphic" composites of form and matter), whereas *substantia secunda* refers to the *essence* that defines the universal class, to which an individual thing belongs – thus, in traditional terminology, every individual human being is a primary substance, whereas "man" is a secondary substance. See [Lübc88] p. 530 et seqq.

Hobbes and de La Mettrie, who, even more provocatively and grotesquely, abolished man's soul as well.[1934] Indeed, Hobbes and de La Mettrie still have a bellicose and vociferous following, although few will consider Descartes demotion of the animals to a state radically different from man's very convincing presently.

Similarly, Descartes framed a mechanistic-deistic conception of the world at large as a great machine or clockwork shorn of all teleology, but ruled by a few mechanical laws of motion and activated by a distant, deistic God in a shadowy *Urzeit.* In effect, he thus abolished forms and ideas as objective entities, as he, following Galileo, Democritus, and the ancient atomists, adopted the reductionist distinction between *primary* and *secondary properties,* thereby making forms and ideas something subjective, derived, and illusory created by the senses and altogether secondary in importance to the objective, mathematical properties of the *res extensa.*

His rationalist dualism immediately turned out to provide a very unstable foundation for philosophy, leading over to a philodoxy reminiscent of that of the Sophistic Enlightenment of ancient Greece, as his ideas were radicalised in a plethora of different ways: Spinoza arrived at the naturalist, or shall we say pantheist or atheist, conclusion that there really is only one self-existent substance, viz. *deus sive natura.* Hobbes similarly abolished the soul and reduced everything to the substance matter (materialism). Leibniz instead, it appears, abolished matter and laid the foundation for idealism through his doctrine of a plurality of hylozoic monads arranged into a pre-established harmony.[1935] Locke, questioning the very concept of substances, put the emphasis on experience itself (empiricism).[1936] Geulincx upheld Descartes' dualism, but resolved the difficulty of the interaction between soul and matter by the notion of God's permanent intervention (occasionalism), which Malebranche extended to all causal interactions and to all perceptions through the *vision en Dieu,* thereby eliminating both Descartes' disturbing deism and his unconvincing reductionist deconstruction of the forms, while also paving the way for Berkeley's idealism, Hume's anti-Christian scepticism, and Kant's and the Romantic philosophers' subjectivism. Indeed, the proliferation of philosophical systems that resulted from Descartes' proud evocation of the spectre of "method" and the ogre of unrestrained rationalism by necessity resuscitated the very kind of scepticism he had wished to overcome, as, perhaps, best epitomised by Pascal's famous characterisation of man as a "ruiseau qui pense", a reed which thinks, and his no less famous remark, so devastating as to the rationality of rationalism, "le coeur a ses raisons". Nor has Western philosophy as yet been able to recover from the morass of philodoxy it precipitated itself into at this time.

Descartes' mechanistic-mathematical conception of space as a *plenum* filled with infinitely divisible particles, which act upon each other by direct contact and move according to three basic laws of nature, was also soon to be subverted by Boyle and Newton, who instead, rather taking their cue from Renaissance Hermeticism and Platonism, conceived of space as a *vacuum,* in which indivisible atoms acted on each other over a distance by means of the strikingly mystical-occult gravitational force.[1937] In contrast, the Cartesian notion of a mathematical science, where about everything was to be mathematised, has indeed been very influential, but was hardly very original. Galileo, Dee, the Renaissance Platonists and Cabalists, to say nothing of Pythagoras, Euclid, the Chartres Platonists, the Oxford school of Robert Grosseteste and Roger Bacon, Raymond Lull, some Ockhamist Schoolmen, such as John Buridan and Nicole Oresme, all had a strong

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[1934] See [Rose41], [Kirk61], [LaMe60], and [Vart73].

[1935] [Coud99] p. 308 et seqq. denies that Leibniz himself is to be characterised as an idealist and claims that the monads "are basically fields of force that anticipate modern field theory". Accordingly, his vitalistic hylozoism will, we are told, have its roots in Aristotelian hylomorphism, Renaissance occultism, Kabbalah, Paracelsianism with its concept of *archeus,* and, in particular, alchemy, of which he, like his friend van Helmont, who possibly influenced his conception of the monads significantly and may be the source of the term "monad", was an avid adept. In this interpretation, the pre-established harmony is not a predestination of the monads so that they, like wound-up clocks, tick along at the same rate, but rather "describes analogous modes of causation viewed from different perspectives", where an "emanation and volitional model" apply to God's and the monads' finalistic causation, as both God and the monads are active, mental entities, whereas a "mechanical model" obtains for passive physical bodies. Thus, the pre-established harmony bridges the models of causation that rule the *mundus intelligibilis* of the monads and God and the *mundus sensibilis* of physical bodies, respectively, so that to a conation in the former will correspond a motion in the latter (see [Leib98] §78-81; cf. also id. op. p. 113 et seqq.). From this we can also conclude that the volitional model is the most basic of these three Leibnizian models of causation, of which the other models will only appear as different perspectives. See also [Coud95] p. 78 et seqq., [Fran89], and [Benz83a] p. 48.

[1936] Thus Spinoza advocated *substance monism,* Hobbes materialist *property monism,* and Leibniz idealist *property monism,* which also is a *pluralism,* since Leibniz accepts a plurality of souls.

[1937] For a remark on the significance in this context of the Renaissance Platonists' idea of *spiritus mundi* and Newton's conception of space as a *sensorium Dei,* see footnote 2072 on p. 448.

fascination for mathematics and its key significance in the exploration of nature.[1938] In particular, astrology, still indistinguishable from astronomy at this time, was the revered stronghold of advanced mathematical methods, all since the hey-day of Babylonia providing the prime motive for the cultivation and furtherance of mathematics, as attested, for example, by Ptolemy's *Almagest.*[1939]

So what is the real significance of Descartes' philosophy? In our contention, Bruno Latour gets close to the heart of the matter in his thought-provoking and much-debated study *We Have Never Been Modern.* According to his ingenious and intriguing – but in some respects perhaps somewhat simplistic – argument, "the Great Divide" between "objective" nature/things/science and "subjective" humanity/culture/society/politics/ethics established by Descartes is together with his "crossed-out God, relegated to the sidelines" an essential part of "the modern constitution", which makes it possible for modern technoscience to keep churning out a steady flow of disruptive new phenomena and inventions by effectively short-circuiting the countervailing forces, which predominated in the pre-modern world.[1940] According to Latour, we have, in spite of the establishment of "the modern constitution", never really been modern, as all these novelties nonetheless clandestinely hybridise nature and culture (as "quasi-objects" in Latour's lingo), albeit, by virtue of the modern constitution, unhampered by the built-in conserving *vis inertiae* of the "anthropological matrix", in which all kinds of entities, be they of the order of nature, of society, or of discourse, are in fact complexly and subtly interrelated.[1941] Thus, by laying the ground for the formula, by which the "anthropological matrix" could be suspended, Descartes will be the father of modern technological "progress" and the gnostic-utopian attempts to reconstruct the world rather than the conqueror of scepticism he aspired to be.

There has been some speculation about the possible connections between Descartes' efforts to create a new foundation for science and knowledge and the 'Rosicrucian Enlightenment' that followed upon the publi-

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[1938] Notably, the erudite occultist, mathematician, and angelic interlocutor John Dee was through his famous *Mathematicall Preface* to Billingsley's translation of Euclid instrumental in promoting the mathematical-mechanic approach to science that became so influential in the 17th century (see [Fren84] p. 160 et seqq.), as witnessed by the application of different varieties of the "geometrical method" also to philosophical problems, by Dee himself in his *Monas Hieroglyphica,* and later by Galileo, Descartes, Mersenne, Hobbes, Spinoza, Pascal, Leibniz, etc. Additionally, the use of the geometrical method in philosophy will have been much fostered by the popularity Proclus' *Elements of Theology* [Proc63] enjoyed all since the Middle Ages, during which the essence of it was traded down in the influential pseudo-Aristotelian *Liber de causis,* and, even more so, after the publication of Patrizi's fresh translation in 1583. In this work, the hyperrationalist Neoplatonic philosopher brought the deductive-geometrical approach of Euclid's *Elementa* to bear on metaphysics and theology, deducing no less than 211 propositions *more geometrico.* Proclus was also the author of a similarly conceived *Elements of Physics* and a *Commentary to the First Book of Euclid,* which influenced Kepler greatly (see [West84b] p. 203 et seqq.). Also his influence on Western mysticism and occultism is immense both through the intermediation of the pseudo-Dionysian corpus, John Scotus Eriugena, and the pseudo-Aristotelian *Liber de Causis* and *Theologia,* and through his own writings, which wielded a decisive influence on such pioneers of modern perceptions as, for example, Meister Eckhart, Tauler, Nicholas of Cusa, Pico della Mirandola, Ficino, Agrippa, and Hegel (see [BM92], [Saff82], [Beie98] p. 44 et seqq., [Cope88], [Proc63] p. xxxii, [Pico73] p. 8, and [Beie72] p. 154 et seqq.). Proclus' use of the geometrical method on theology and physics will ultimately have been motivated by the – originally Aristotelian – tripartition of philosophy into a dialectic, a practic, and a theoretic branch, the last of which consists of mathematics, physics and theology, i.e. the three areas to which Proclus deemed the mathematical-geometrical method applicable. Cf. [Merl63] p. 62.

[1939] See [Thor55]. Cf. also [Test87] and [Curr89].

[1940] [Lato93]. Cf. also [Schw86] and [Lind79] p. 126 et seqq.

[1941] See [Pete82]. Cf. also [Mazl93] p. 68 et seqq. and [Cohe66] p. 109 et seqq. [Eamo94] p. 38 et seqq. and, following him, [Coud99] p. 335 et seq. point out that the polemics of the Christian Fathers and medieval theologians against *curiositas* as a form of sinful *concupiscentia,* desire, will have had a highly restraining effect on the pursuit of knowledge and, thus, implicitly on technoscience. In particular they adduce St. Augustine's famous reflections in the fifth book of the *Confessiones* on the uselessness of worldly knowledge in man's quest for God. Here, St. Augustine makes the statement, most unpopular with those who should be most concerned, that God is near him who has a contrite heart, but does not let those inflated by their own knowledge and learning find Him *(V.III.3):* "Quoniam magnus es, Domine, et humilia respicis, excelsa autem a longe agnoscis nec propinquas nisi obtritis corde nec inveniris a superbis, nec si illi curiosa peritia numerent stellas et harenam et dimetiantur sidereas plagas et vestigent vias astrorum." The purport of this *topos* is of course that worldly learning is of no use for man's salvation and may, insofar as it makes men proud and conceited, obstruct the infinitely more important pursuit of God, but it seems unwarranted to construe the passage as a wholesale condemnation of the pursuit of knowledge *per se.* Nevertheless, St. Augustine and the other Fathers were surely no friends of *vana curiositas,* nor were the great Schoolmen, such as St. Thomas, who made the important distinction between proper *studiositas* and improper *curiositas.* Influential as mementoes of the culpability of *curiositas* will also have been the paradigmatic stories of the Fall of Man, Icarus, Daedalus, and Prometheus, and the myths surrounding real or imagined magicians, such as Gerbert of Aurillac, Michael Scot, Petrus Abelardus, Albertus Magnus, Robert Grosseteste, Roger Bacon, and, of course, the redoubtable Faust (see [Thor23], [Butl79a-c], [Kret68], [Maha80], [Baro82], [Thor65], [Alle1892], [Stur80], and [Moll74] – and [Henn66] for a full bibliography). On the *Wirkungsgeschichte* of the story of Thales' fall into the well, similar in tenor, see [Blum87]. Additionally, [Blum99b] p. 263 et seqq. provides a history of the shifting attitudes to curiosity throughout Western history.

cation of the so-called Rosicrucian manifestos a few years before Descartes' meditative sojourn in Ulm.[1942] The Rosicrucian manifestos were two vehemently anti-Catholic and anti-Scholastic tracts, possibly written by someone – according to many scholars, either the Lutheran pastor Johann Valentin Andreae or he and his circle of friends, including Tobias Hess and Christoph Besold – associated with the court of the Palatine Elector, Frederick V, the famous 'Winter King' of Bohemia, about whom the German Protestants nourished great expectations, hoping that he would put an end to the domination of the Catholic Hapsburg dynasty in Germany and rekindle their own reformatory efforts. These hopes soon foundered, as the very army, in which Descartes had enrolled, defeated Frederick utterly in the battle at the White Mountain in 1620 and the terrors of the Thirty Years' War ensued. The Rosicrucian manifestos, which caused widespread enthusiasm and much speculation in Protestant circles and considerable alarm amongst Catholics, claimed to issue from a secret, albeit probably wholly fictional, Rosicrucian society, pictured as a kind of Protestant counterpart to the Jesuits, and, like Francis Bacon's much more elaborate writings also composed in the early 17th century, drew up a programme for a new kind of science, envisioned as the crucial element in a general Protestant-utopian reformation of both religion and society.[1943] This new Rosicrucian "science", strongly tinged by the extraordinary millenarian hopes of this epoch – as seen, for example, in authors such as Postel, Bacon, Behmen, Comenius, and, in Sweden, Buraeus – was to be based on the Hermetic-occult sciences – in particular, alchemy –, the Kabbalah, number mysticism, and the like, somewhat along the lines of the philosophy of Paracelsus and Postel and the other Renaissance Hermeticists and Platonists.[1944] The adoption of the Rosicrucian-scientific agenda also was expected to imply a sharp break with the main traditions of Christian thought, which in its Scholastic-philosophic form was subjected to the most violent attacks by the *buccinatores novi temporis,* such as Francis Bacon, who compared the school philosophy to a sterile virgin and recommended that nature, instead of being contemplated, should be put violently to the rack through experimental science in order to reveal her secrets to man so as to enable him to become the master of creation and get a maximal yield from her "to the relief of man's estate".[1945] During his stay in Germany, Descartes, as many other young intellectuals, attempted to get in contact with the Rosicrucians and on his return to Paris in 1623 there were rumours that he was indeed a member of this much-feared society – rumours that were to resurface every now and then.

[1942] See [Yate75] p. 150 et seqq. – Frances Yates' époque-making work on the *Rosicrucian enlightenment* –, [Shea88], [Åker98] p. 221 et seqq., and [Kahn01] p. 295 et seqq. In [Yate75], the term the 'Rosicrucian Enlightenment' was introduced as a designation for the last, predominantly Protestant (German and British), phase of the development of the Renaissance synthesis of occult-mystic philosophy, when to the original stew of Hermetic natural magic and Cabalism, as worked out in the writings of Ficino, Pico, and Agrippa, was added an element of Paracelsian alchemy and medicine. [Yate75] p. 58 et seqq. made John Dee the spiritual father of Rosicrucianism, although many scholars, such as, for example, [Good99], [Kahn01], and [Gill95] p. 22, have expressed doubts about Dee's importance. In the 70s, a heated debate started over the "Yates' thesis" that raged for many years, although it seems to have petered out now. Typical of the negative reaction, the preface of [Vick84] (see also [Vick79]) is framed as an – rather peevish and, in the end, unilluminating and unconvincing – *Ehrenrettung* of science from its occult roots, as established in Yates' and others' writings, through the reliance on a kind of schizoid division of attitudes into (implicitly bad) "occult" and (implicitly good) "scientific" ones, which, although they regularly coexisted in one and the same person, are declared to be "mutually incompatible". Rather than lapsing into such absurdly anachronistic projections of modern categories and distinctions on olden times, we must of course interpret the different views there were then in terms of the *contemporary* issues and conflicts – between Protestants and Catholics, Aristotelians and Platonists, etc. A much more sensible and, on the whole, approving assessment of Dame Frances' seminal work can be found in [Cope90]. Additionally, [Cope88] shows that some *prima facie* Hermetic influences are rather Neoplatonic ones, whereas [Gill95] p. 22 finds fault with the rôle Yates attributed to John Dee as the father of Rosicrucianism. See also [Coud99] p. 330 et seqq., [WM77] (rather devastatingly reviewed by [Cope78]), [Curr85], [MD88a], [Cohe94] p. 169 et seqq., [Whit99], [Kahn01], and [Gibb01] p. 38 et seqq. Cf. also [Mont71] on Johann Valentin Andreae, whose alleged authorship of the Rosicrucian manifestos is here rejected. On the history and origin of Rosicrucianism, see [McIn97], [Arno90], [Wait93], [Schi42], [Peuc67] vol. III, [McIn92], [Edig95], [Edig98], [Gill94], [Gill95], and [Åker98]. Cf. also [Åker].

[1943] Cf. also [Webs75].

[1944] As an aside, it may be interesting to note that astrology, which, albeit one of the three "occult sciences", does not seem to sort altogether well with the general humanistic-optimistic and freedom-asserting disposition of the Hermetic-Platonic philosophy, as witnessed by for example Ficino's and Pico's attacks on it, was occasionally – in such figures as Vanini and Pomponazzi – rather part of a fatalistic outlook interpreted as "atheism" by their contemporaries and as "Renaissance naturalism" by present-day scholars (see [Gari90] and [Hine84]). In fact, astrology had been closely welded to Aristotelian philosophy by the great Moslem astrologer Albumasar (see [Lind92] p. 279 et seq.).

[1945] Cf. [Fort95] p. 215 et seqq., who, taking issue with [Whit67], points out that Bacon's violent, instrumentalist attitude to nature and his odd re-interpretation of *Genesis* are at odds both with the traditional Christian and Biblical view of man as a fallen, sinful creature and the Christian sense of respectful admiration for God's handiwork. In spite of its Christian varnish, Bacon's attitude is rather the child of Renaissance Hermeticism and Neoplatonism. Notably, much the same violent cult of power and utility, and in particular state power and state utility, as is found in Bacon's writings, permeated the entire Protestant Reformation with its attacks on the 'idle' and 'useless' monastic, contemplative form of life and its across-the-board confiscation of Church property in the interest of the state and its ruler (see [Nyma97] p. 215 et seqq.).

Whatever we are to make of these rumours, it seems that the Rosicrucian furore might have made a certain negative impact on Descartes' method, his conception of science, and the strict mechanism and sharp dualism he advocated. Possibly, these traits, at least to some degree, reflect the air of suspicion that the whole complex of animistic, Hermetic-Cabalistic and Neoplatonic philosophy and occultism was, all since the onset of the Counter Reformation, increasingly surrounded by in Catholic circles.[1946] This was partly the result of the more restrictive post-Tridentine climate of opinion, partly a consequence of the Rosicrucian furore and its associations with the Protestant plots that started the Thirty Years' War in Germany, but it was also fomented by the general tendency towards heterodoxy and neo-paganism, if not atheism, amongst the proponents of such ideas, such as Giordano Bruno, Girolamo Cardano, and Tommaso Campanella.[1947] Thus, a great part of Descartes' significance – despite his private leanings to the occult – may lie in his having, together with Mersenne[1948], Gassendi, Galileo, Kepler[1949], and other philosophers and scientists living in the Catholic part of Europe, extricated mathematics and mechanics from their age-old associations with magic, numerology, and occultism of the Hermetic-Cabalistic and Pythagorean-Platonic complexion and shaped the attitude of nominalism, phenomenalism, and scepticism so entrenched amongst scientific practitioners today that it is hardly even noticed, but simply taken to be the "scientific approach".[1950]

Within Protestantism, the Hermetic element in science, philosophy, and, through Comenius, education, however, remained vital much longer, and it would, in a somewhat popularised form, live on in Freemasonry and its various offshoots to this day.[1951] For one thing, Boyle's *Invisible College,* the forerunner of the *Royal*

[1946] [Toul93] p. 45 astutely talks about the Counter-Renaissance of the 17th century. Of particular significance for this development will be Francesco Patrizi's abortive attempt to replace Scholastic Aristotelianism with his own idiosyncratic blend of Platonism, Hermeticism, and *prisca theologia* as the foundation of a wide-ranging reform of Catholic philosophy, theology, and education. His Hermetic-Platonic synthesis, although initially causing much interest in leading Catholic circles and rendering him a chair of Platonist philosophy at the *Sapienza,* the papal university of Rome, proved to be fraught with dogmatic problems and had to be dismissed by the Index Congregation, which, consequently, also put his works on the index – see [Leij98]. Later Catholic attempts to draw on the Platonic tradition would be much more modest in tone and limited in scope.

[1947] See [Yate75] p. 139 et seqq. Apparently, with Bruno's abortive attempt to replace Christianity with ancient Egyptian religion (i.e. Hermeticism) the long-lasting experiment of Christianising ancient Platonic-Hermetic ideas, starting with Cardinal Bessarion's sanitisation of Gemisthos Plethon's somewhat similar attempt to replace Christianity with Platonism (cf. [Masa56] and [Wood86]), was finally put to rest in the Catholic world. The strange myth of Bruno's auto-da-fé as a kind of martyrdom for modern science provides but yet another example of how progressivist historiography has tendentiously misrepresented and obfuscated the understanding of historical events. On Bruno, see [Yate64]; on Cardano, see [Graf99].

[1948] See [Hine84].

[1949] Many of the essays in [Vick84] deal with Kepler and his rejection of various Hermetic-occult ideas. Notably, his and Mersenne's polemics against the Rosicrucian Hermeticist Robert Fludd became a cause célèbre with wide-ranging ramifications. It should be noted, however, that Kepler criticised Fludd's imaginative Hermetic geocentricism from a heliocentric, Neoplatonic, geometric-mathematising point of view, largely inspired by the Neoplatonist Proclus, not to be confounded with modern 'scientific' attitudes. Cf. also [Duse99] p. 152 et seqq. For a background on this conflict, see also [Yate66] p. 266 et seqq. On Kepler's astrological ideas, see [Test87] p. 232 et seqq. Also Galileo is usually considered a Platonist (see e.g. [West84b]), although some have also tried to derive his ideas from the Averroist tradition of Padua (so [Rand40]). For some interesting observations on Kepler's and Galileo's use of astrology to promote their own careers, see [Rurk01].

[1950] [Yate75] p. 160 et seqq. suggests that Francis Bacon's often criticised lack of understanding of the rôle of mathematics in science, as evinced in his writings, had to do with the still strong associations between mathematics and magic. Thus, an emphasis on the importance of mathematics might have been repulsive to his employer James I, who was a dedicated enemy of anything that smacked of magic or sorcery, topics on which he also wrote a famous treatise. It should be kept in mind that these were the times when the great witch craze instilled extraordinary fears about the supernatural and anything that could be associated with it. Plausibly, also Bacon's lack of interest in or hostility to the main feats of Hermetic science, such as Copernicus' and Kepler's – astrologically motivated – heliocentric theories, Gilbert's work on the magnet, or Paracelsus' medicine, may be explained along similar lines. That he might have been more influenced by the Rosicrucian ideas than he ventured to spell out clearly during the reign of James I is suggested by the posthumously published *New Atlantis,* where there seem to be several allusions to Rosicrucianism.

[1951] See [Yate75] p. 197 et seqq., [Vick84], [McIn99], and [Tuve64]. The origins of speculative Freemasonry are shrouded in a cloud of mystery, rumours, and speculations, such as Hammer-Purgstall's ingenious theory of a connection between it and the Templars and the Assassins of the Middle East (see footnote 1824 on p. 387 above). Most recently, [Schu02] has tried to link Freemasonry with a tradition of Cabalistic Temple mysticism supposed to go, via the Medieval Kabbalists, the Templars, and the Masonic cathedral builders, all the way back to the Essenes and the ancient Jewish temple building guilds, thereby in effect reviving the late 19th century theory of a grand anti-Christian Jewish-Masonic conspiracy, as, for example, summed up in [Webs67], albeit having replaced the anti-Judaistic or anti-Semitic trappings, which often accompanied this theory, with as disturbing anti-Christian ones. Lately, various amateur historians have also written extensively on the Templars-Masons link, often in an unboundedly speculative or credulous vein, although some valuable discoveries and interesting hypotheses have also transpired. For example, [Robi89] provides interesting circumstantial evidence in support of the thesis – also advocated at length in [Schu02] – that Masonry indeed was established in Scotland shortly after the suppression of the

Society, seems to have been an emulation of the Rosicrucian society of the manifestos. In England, utopian Hermeticism came to be closely associated with the Puritan attempts to reform society and religion. Largely as a consequence of the reconciliatory efforts after the *Restoration* in 1660, the topics of religion, Rosicrucianism, and the occult sciences, having become highly controversial through the civil war, were increasingly shunned in the – public – scientific discourse, as there were within the scientific community in Great Britain numerous sympathisers of all the different factions of the civil war, nourishing strong and irreconcilable opinions on such matters.[1952] Although at this time many leading scientists, such as Boyle and Newton – famously dubbed "the last of the magicians" by Keynes[1953] –, took a passionate interest in these topics, and Newton's theory of

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Templars in the early 14th century as a secret brotherhood of refugee ex-Templars given asylum by the excommunicated Scottish king Robert Bruce, who wished to take advantage of their military skill in his fights against England. Pace Hammer-Purgstall and all these other authors, the evidence for a link between Freemasonry and the Templars, bridging the temporal gulf of more than 200 years to the first indisputable evidence of modern Freemasonry, remains rather thin and doubtful, as does the existence of anything that can conclusively be connected with modern speculative Freemasonry before the late 16th century (see [Stev90]; cf. also [Corb86] p. 263 et seqq., [Åker98] p. 190 et seqq., [Wals38] p. 303 et seqq., [Over94] p. 226 et seqq. and p. 241 et seqq., and [Goul] vol. II p. 381 et seqq.). And although the relation of speculative Freemasonry to the existing guilds of 'operative' (i.e. real) stonemasons, which indeed can be traced back to the Middle Ages and further on to Antiquity, is generally admitted, the exact nature of this connection and the nearer circumstances of the origin of 'speculative' Freemasonry, the wider propagation of which started with the establishment of the *Grand Lodge of England* in London in 1717, are far from clear – perhaps the best guess so far is the theory suggested by Frances Yates and others, relating speculative Freemasonry to Giordano Bruno's Egyptian religion (see [Yate64] p. 414 et seqq., [Fric75] vol. I. p. 242 et seqq.) and the 'Rosicrucian Enlightenment' of the 17th century (see [Yate75] p. 249 et seqq., [Goul] vol. III p. 60 et seqq., [Mack96] p. 329 et seqq., [Schi42], [Arno90], [Stev90] p. 77 et seqq.; cf. also [Bind98] p. 18 et seq., where 39 different more or less fanciful theories on the origin of Masonry are enumerated, many of which are also discussed by [Mack96]). In any case, it seems reasonably clear that early speculative Freemasonry was closely allied to the Hermetic-Rosicrucian circles, from which the *Royal Society* emerged after the Restoration, and was somehow involved in the cabals surrounding the civil war in Great Britain in the mid-17th century and the subsequent conflicts over the throne between the houses of Stuart and Hanover (see [Pors00], [Mell64], and [Schu02]) – so the famous 18th century mason Chevalier Ramsay recounts that he had heard that the Restoration of Charles II had been determined at a Masonic meeting.

As for the possible Oriental connections of Freemasonry, Massignon's and Lewis' thesis that the Muslim guilds originally were set up by Ismaili, or rather Carmathian, revolutionaries, as suggested in [Mass69] p. 368 et seqq, [Mass27], [Mass32], [Mass34a-b], and [Lewi37], was heavily criticised by [Ster70] and [Cahe70] and has now been generally abandoned, as these guilds are now held to have originated only later – cf. also [RFN97], [Taes65], [Schu02] p. 30 et seqq., and [Blac84] p. 53 et seqq. In any case, the association of the Muslim – or Jewish (see [Schu02] and [Wisc71]) – guilds with the Christian guilds of Stonemasons in Medieval Europe will at best be speculative and extremely moot. On the other hand, there is other circumstantial evidence suggestive of possible Oriental influences. For one thing, the allusions made in the Rosicrucian manifestos published in 1614 to Damcar (not a name for Damascus as falsely held by many earlier scholars, but a variant spelling of Damar, the seat of an important Zaidi *madrasa!)* in the Yemen – the only country in the Moslem world where Ismailism was still going strong after 1256 (cf. [Åker98] p. 40 et seqq., [Gill95] p. 80, and [Daft90] p. 256 et seqq.) –, to Egypt, and to Fez call out for an explanation and may, perhaps, be used to develop von Hammer-Purgstall's basic ideas along new lines, whether these allusions, as has been suggested (see [Åker98] p. 96 et seq.), have been moulded on the story of the travels of the Jewish magician Abraham ben Simeon as recounted in the manuscript sometimes referred to as *Cabala Mystica* or *The Book of the Sacred Magic of Abra-Melin the Mage* or not. Also after the loss of the Holy Land to the Muslims, a number of famous personages associated with esoteric lore, such as Raymond Lull, who was able to convince the Council of Vienne in 1312 of the need for including Arabic into the curriculum taught at the Christian universities, Cornelius Agrippa, Paracelsus, Guillaume Postel, who was given the first university chair in Orientalism, created in 1539 at the Collège de France, and took a curious interest in the religion of the Ismaili sect of the Druzes, Cagliostro, Comte de Saint-Germain, and the mysterious Franz Kolmer, who, according to a rumour recounted by [Barr73] vol. 2 p. 24 was the spiritual father of Adam Weishaupt, paid visits to the Orient or North Africa, or are rumoured to have done so, thereby making it possible for scholars to attempt to discern influences from Oriental esotericism in their writings and teachings. See [Rodi87], [Åker98] p. 173 et seqq. and p. 202 et seqq., [McIn97] p. 25 et seq., [Bamf99] p. 61, [Gill95] p. 18 et seq., [Yate75] p. 85, [Dara89] p. 195 et seq. (but cf. [Rawl98] p. 524 et seqq. on the doubtful credentials and preposterous claims of this author), [Bouw57] p. 47 and 109, [Page58] p. 13, and [Russ94]. In addition, many other philosophers and writers of a mystic bent, such as Roger Bacon, Nicolaus Cusanus, Leibniz, and Goethe, just to name a few, took considerable interest in Moslem philosophy and religion. Cf. also footnote 1871 on p. 397.

Much of the literature on Freemasonry is written by amateur historians and enthusiasts and may at times appear curious, speculative, unscholarly, excessively apologetic, or otherwise tendentious to the scholarly eye. Despite some – rather obvious – idiosyncrasies in some of these works, I have found [Wait], [Maco00], [Goul], [Mack96], [Schn47], [Stev90], [Head49], [LeFo70], [LeFo79], [LeFo87], [Fric73], [Fric75], [Jaco81], [Naud82], [Kerv99], [Ligo00a-b], [Bind98], [Bied88], [Rein89], [Rein93], [Hann84], [Knig84], and [Boko80] to be useful. A bibliography of the immensely large older literature is provided by [Wolf23]. See also [Nobl99] p. 73 et seqq., [Davi98] p. 102 et seqq., [Tuve82] p. 170 et seqq., [Lamm] part II p. 3 et seqq., and [Bill80] p. 86 et seqq. et passim.

1952 For one thing, religious and political discussions were disallowed at the meetings of the *Royal Society,* as they were at the meetings of the Freemasons. See [Shap96] p. 133 et seqq. Cf. also [Broo91] p. 114 et seqq. and [Cony01]. On the change in the climate of opinion in the *Royal Society* during the early 18th century towards deism, materialism, and atheism, see [Olso82] vol. II p. 135 et seq.

1953 See [Prin98], [Fier53], [MR66], [Ratt72], [West72], several essays in [BS75], [McGu77], [West84a], [Dobb88a-b], [Dobb91], [Whit97], and [DJ95]. On Newton's debt to Behmenist thought, which already William Law identified as the hotbed, from which his physical ideas grew, see [Popp35] and [Gibb01 p. 48 et seq. The strange fate of Newton's manuscript notes, the donation of which the Royal Society, Cambridge University, the British Museum, and the Harvard, Yale, and Princeton Universities all turned down, bears witness to the enormous embarrassment the truth about Newton provided to the mythologers of modernity (see [Popk88]).

gravitation, which in effect put an end to the Cartesian mechanistic worldview and its conception of matter as entirely passive, was doubtless largely inspired by his extensive alchemical studies[1954], the British scientists' self-imposed restraint gave added weight to "the Great Divide" between "objective" science and "subjective" religion, politics, mysticism, philosophy, etc. about to be established by the Cartesians and over time grew into a taboo, which came to appear as constitutive of the scientific attitude. Indeed this taboo is still effective, although it has had a long and devious – largely unwritten – history of its own. Later, Hermetic-Platonic ideas would re-appear ever and anon in diverse Romantic, occultist, esoteric, theosophic, and, lately, 'New Age' shapes, but would mostly be looked askance at by the scientific community[1955], although it also seems clear that many scientists and philosophers, and in particular the more creative ones, have tacitly continued to take a strong interest in occult and mystical topics and participate in various occult-mystical pursuits, as can, for example, be gathered by a study of the membership lists of the societies concerned with psychical research and parapsychology.

1954 The same will apply to Newton's interest in optics, a pastime much cherished amongst Western alchemists and other practitioners of the occult sciences all since the Middle Ages, when leading intellectuals with an interest in occult lore, such as, for example, Albertus Magnus, Robert Grosseteste, or Roger Bacon, started to pursue keenly the science of 'perspective', as it was known in the early days. Later, this connection, fomented by the popularity of various schemes of light mysticism and light metaphysics, by the theories about light as a propagator of astral influences, and by the Neoplatonic-Hermetic conception of the Sun, Moon, stars and planets as gods, was reinvigorated by John Dee's alchemical theories. The birth of modern science is closely associated with this interest in optics, which brought forth instruments, such as the spectacles, the telescope, and the microscope, which were to change the worldview radically. The source of the Western occult-scientific pre-occupation with optics is to be found in the writings of Arab scientists and philosophers, such as Alhazen and al-Kindi. A late exponent of optical mysticism was of course Goethe. See [Lind81]. Cf. also [Crom53] p. 128 et seqq., [Lind86b], [Lind92] p. 307 et seqq., [Colp99] p. 45 et seqq., [Szul], [Funk86] p. 63 et seq. note 22, [Cant67], and [Hans86] p. 134.

1955 [Hane98a]

3.3.6.3 Modernism Takes Command

Aufklärung ist der Ausgang des Menschen aus seiner selbstverschuldeten Unmündigkeit.

Immanuel Kant[1956]

If therefore the light that is in thee be darkness, how great is that darkness!

Ev. Matt. 6:23

And many false prophets shall rise and shall deceive many. And because iniquity shall abound, the love of many shall wax cold.

Ev. Matt. 24:11-12

And for this cause God shall send them strong delusion, that they should believe a lie: That they all might be damned who believed not the truth, but had pleasure in unrighteousness.

2 Ep. Thess. 2:11-12

We do not admire, we hardly excuse, the fanatic who wrecks this world for love of the other. But what are we to say of the fanatic who wrecks this world out of hatred of the other? He sacrifices the very existence of humanity to the non-existence of God. He offers his victims not to the altar, but merely to assert the idleness of the altar and the emptiness of the throne. He is ready to ruin even that primary ethic by which all things live, for his strange and eternal vengeance upon some one who never lived at all.

G. K. Chesterton[1957]

In the wake of the towering religious, intellectual, political, and economic chaos, which had been mounting all since the High Middle Ages, only apparently reaching a crescendo in the enormous expressions of pneumapathology during the Renaissance and the early modern era[1958], but further aggravating throughout the 18th century, followed a major bouleversement in the outlook of the intellectual élites of the West through the incidence of what is usually referred to as the 'Enlightenment', the phenomenon generally held to mark the *bona fide* onset of the current era of modernism. The usage of the vocable "Enlightenment" for what was essentially a thrust towards secularism and irreligion may strike one as odd, as "enlightenment", *illuminatio,* had until then primarily been a theological term used to designate the process, by which the believer, through the workings of the Holy Ghost in his soul, becomes aware of his own sinfulness and God's saving grace, as well as a philosophical concept used in the Augustinian-Platonic tradition to denote the way the divine ideas, the archetypal *rationes aeternae,* are instilled in the soul by the divine light, facilitating our recognition of truth, goodness, and perfection and providing a foundation for a certainty and understanding that sense perception cannot alone bestow.[1959] In addition, the notion of enlightenment or illumination was, however, also associated with the various heretical, more or less explicitly antinomian groups – from the Medieval Amalricians, Cathars, and Brethren of the Free Spirit to the more recent Alumbrados, Guérinists[1960], and Quietists – of soi-disant enlightened ones, *illuminés,* who claimed to be incapable of sinning by virtue of their own illumination by the

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1956 [Kant1784]

1957 [Ches1908] p. 239

1958 There were two different sides of this coin of pneumapathology: Firstly there was a strong thrust towards *secularisation* driven by the growth of irreligiosity, political Machiavellianism, and moral corruption, showing, for example, in the enormous greed and ruthless national and economical expansionism of the states and their leaders, in the Protestant destruction of the Catholic monastic-ecclesiastic culture, or in the butchering of the Indians and the revival of slavery in America. Secondly, there was a *sacralising* trend in the opposite direction, towards religious fanaticism, neo-paganism, and neo-Gnosticism, which was reflected in, for instance, the occult revival, the bouts of enthusiast apocalypticism, the dance manias and flagellations, the witch-craze, the religious wars, etc. See below p. 442. Cf. also [Whit68] p. 169 et seqq.

1959 [Mull85] p. 142 et seq.

1960 It may be interesting to note that the Protestant Rosicrucians were by their contemporary critics commonly associated with the illuminist Alumbrados and Guérinists (see [Kahn01]). Similarly, the Freemasons of Florence were accused of Molinism and Quietism by the inquisitors, who in the late 1730s investigated their activities (see [Fric73] p. 234 et seqq.). Quietism seems to have exerted a rather wide influence on early Freemasonry, in particular through Chevalier Ramsay (see [Fric73] p. 179 et seqq.).

Holy Spirit and, thus, able to commit any misdeed with impunity. It was from these latter – and other similar – occult-Gnostic currents, abhorred and combatted by the Christian Church all since its earliest days, that the sap of the Enlightenment primarily gushed forth. The publication in 1699 of Gottfried Arnold's *Unparteische Kirchen- und Ketzergeschichte,* which, by depicting the orthodox as heretics and the Gnostic heretics as the true Christians, inaugurated the kind of inversion of history and commitment to Gnosticism that theoretically underpin the modern project, can be chosen as a landmark in this development.

In fact, such views had been implicitly rife amongst leading intellectuals of the 17th century such as Milton, Newton, and many other philosophers, mystics, occultists, scientists, and libertines, and had even been pre-figured by Bodin and radical-mystical Protestants in the 16th century.[1961] During the 18th century, the Gnostic ideas were disseminated to the wider strata of society through intense propaganda and pamphleteering and, in particular, through the intermediation of Freemasonry, a curious crossbreed between a seemingly harmless parlour-game and a novel, somewhat artificial Hermetic-deistic quasireligion, offering to the prospective member all the irresistible frissons and gains of the powerful secret society[1962], including mystical initiations and occult secrets, useful friendships, fraternal support, status advancement, and other social benefits, and various amusements and the prospect of hobnobbing with the bigwigs of society.[1963] Although

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[1961] See [Rose80], [Gill00], [Will00], [Dülm77], [West55], and [Part87] p. 94 et seqq. Cf. also [Manu83].

[1962] A good introduction to the phenomenon of secret societies is provided in [MacK67]. See also [Elia01].

[1963] On the origin of Freemasonry, see footnote 1951 on p. 418. The rôle of the Freemasons in the convulsions of the 17th-18th centuries is enigmatic and controversial, the whole issue jangling with all kinds of shrill political overtones and being tainted by the stigma of "conspiracy theory" (cf. footnote 1824 on p. 387). In particular, the part Masonry played in the revolutions of the 18th and 19th centuries has been much and heatedly debated, but although, for example, such personages as Washington, Franklin, Napoleon (see [Tuck14]), Bolivar, Garibaldi, Cavour, Mazzini (see [Hale]), and most of the leaders of the French revolution were Masons and the Swedish revolution in 1809 even brought onto the throne the Swedish Freemasons' Grand Master, into whose possession, besides, the famous 'Schweden-Kiste' with the leading illuminist conspirator Bode's papers (see footnote 1824 on p. 388) had passed already in 1804 (see [Aget84] p. 48), many scholars would ardently dispute the conclusion of [Faÿ68] p. 203 that Freemasonry, by propagating the whig ideas that prevailed in Great Britain through "the glorious revolution" in 1688, "constitue le lien entre la Révolution de Angleterre, celle des Etats-Unis et celle de France". Be that as it may, a disproportionate portion of, for example, the signers of the American declaration of independence (see [Heat97]) and of the Breton club, from which the Jacobin club emerged during the French revolution, were in fact Freemasons, as was a baffling number of leading radical-progressivist intellectuals, revolutionaries, philosophers, artists, scientists, and engineers of this period (see [Boko80] p. 472 et seqq. and [Guig]). On the Masonic involvement in the American Revolution, see [Bull96], [Mors24], and [York93]. The alleged Masonic-Illuminist background of the symbolism of the Great Seal of the United States is dismissed in [PD78] p. 529 et seqq., although this hefty tome can hardly be regarded as the last word on the matter – in any case, similar symbols appear in the iconography of the French Revolution (see e.g. the illustrations in [FO89]). See also [Ligo69] and [Bill80] p. 99 et seqq. on the connections between Masonic and revolutionary symbolism. The literature on the rôle of Masonry in the French Revolution is bulky and almost exclusively authored by polemical French scholars; some significant contributions are [Coch21] (cf. also [Meau28], [Égre55], [Fure81] p. 164 et seqq., and [Pors01] p. 95 et seqq.) [Mart26], [Faÿ68], [Bill80], [Lama81], [Davi87], [Webs92], [Pors98a], and [Pors01]. Additionally, no. 197 (Juillet-Septembre 1969) and 215 (Janvier-Mars 1974) of *Annales historiques de la Révolution française* were devoted to the rôle of Freemasonry in the French Revolution. Cf. also [Darn70] for an interesting discussion of the rôle of Mesmerism in the formation of the revolutionary mood of 18th century France.

There are also puzzling connections between the revolutionary events and Adam Weishaupt's *Illuminatenorden,* which, masquerading as a mystical high-degree superaddition to Freemasonry, but clandestinely – unbeknownst to the rank and file of the order – supporting the atheistic-materialistic, republican-egalitarian agenda of the ultraradical Enlightenment and plotting to stamp out religion, monarchy, private property, marriage, and family life, attempted to overturn the *ancien régime* of Germany and other countries from the inside by secret infiltration and proselytising amongst officers of the state and the members of Masonic lodges. Notably, it was able to penetrate leading circles of French Freemasonry, in particular of the lodge *Amis Réunis,* which not only counted some of the most powerful men of France amongst its members and, together with the "philosopher lodge" *Neuf-Sœurs,* was ranked the most prestigious of the French lodges, but in fact was, through its members, dominated the entire *Grand Orient de France,* the organisation in control of almost all French Masonic lodges (see [Pors01] p. 65 et seqq.). Two years before the outbreak of the French revolution, the leadership of *Amis Réunis* was, through the successful machinations of the German illuminatus Bode, brought under the sway of the illuminist ideas and became secretly affiliated to Weishaupt's order through an organisation of *Philadelphes,* a kind of inner, illuminist lodge (see Schüttler's introduction to [Bode94]; cf. also [Ross98a], [Wern83] and [Pors01]). Other important conduits of German illuminist influence in France were Bonneville and Mirabeau, who both came to play prominent rôles in the French revolution (see [Wils44], [Pors96], and [Bill80] p. 96 et seqq. et passim). Fatefully, Weishaupt's organisation was destined to, directly or indirectly, become the prototype of most secret revolutionary and nationalist societies of the 19th and 20th centuries – see [Bill80] and [Schü97], who concludes "Die Unterwanderungsstrategie nach dem von Weishaupt erfundenen Kaderprinzip wurde in der Folge zum Exportschlager: alle seit dem frühen 19. Jahrhundert agierenden Untergrundorganisationen benutzten Weishaupts Idee des 'langen Marsches durch die Institutionen' bzw. der Organisationsform nach dem - später so genannten - Kaderprinzip und der beschleunigten Aktion." In addition, the Masonic lodge provided the prototype for today's political parties (see [Roga79]). A crucial link in the propagation of Illuminist organisational principles was Buonarroti, whose ideas, directly or indirectly, influenced most latter-day revolutionaries (see [Bill80], [Lehn56], [Eise59], and [Kuyp60]). [Head49] describes the strong radical, anti-Catholic political influence of Freemasonry on the third republic in France, which was paralleled in many Catholic countries. See [SM] for a bibliography of the extensive literature on the Illuminati, [Weis89] or [Schü97] for short surveys of their history, [LeFo01],

Freemasonry, which after the establishment of the *Grand Lodge of England* in London in 1717 would soon become all the rage and spread like wildfire all over the civilised world, originally came with some Christian trappings and its founding documents explicitly excluded atheists and libertines from membership, it before long became closely associated with deism and other radical deviations from the Christian dogma.[1964]

Additionally, more radical, explicitly anti-Christian or generally anti-religious varieties of the Gnostic agenda soon began to mushroom, such as those advocated by the English and Dutch deists and the French *philosophes,* once again proving that atheism, nihilism, libertinism, and anomie always lurk around the Gnostic corner, just as we ascertained in the case of ancient Gnosticism and the Ismaili revolutionaries. In fact, the Enlightenment was by these energumens forged into a frenzied Luciferian onslaught on the Christian religion, which until then had provided the very mettle, soul, and spirit of Western civilisation, a concerted attempt to pull down the Christian Kingdom of God and replace it with its inversion, the Reign of Man.[1965] The devotees of this new movement committed themselves to a total break with the Christian past, which they derisively declared a complete mistake and failure, and to the erection of an anti-Christian church of Reason, Science, and Man. Their impetus being entirely destructive and reactive, the grand gnostic negation and inversion of all things Christian, a Promethean rebellion against God and the codex of morals taught by the Church – and against the traditional order of society, the *ancien régime,* in their eyes compromised both on its own accord and by its alliance with the Church and the Christian religion – having its roots in a thoroughgoing odium against Christianity and anything that could be associated with it[1966], their new mode of thought, aptly becoming

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[Enge1906], [Dülm75] (cf. also [Fehn79]), and [Aget84] for more comprehensive treatments, and [Rach84] for a selection of original texts. Cf. also [Stau18], [Ludz79], [Hamm80], [Rein97], and [Hipp98].

As noted already by [Barr73] vol. II p. 299, the project of the *Encyclopédie,* which, moulded on the British Freemason Chamber's *Cyclopaedia,* was to become one of the principal vehicles for the propagation of the ideas of the radical Enlightenment, was apparently first suggested in the famous and influential speech made by Andrew Michael Ramsay at a Masonic assembly in 1736 (see [Luqe54], [Shac67], [Fric73] p. 179 et seqq., [Walk72] p. 239 et seq., and [Nobl99] p. 78). The Templar legend cultivated in some Masonic circles – possibly also going back to Ramsay's speech – with its emphasis on *vengeance* for the death of Jacques de Molay could be strongly anti-papal and anti-royalist in tenor, to say nothing of such practices as decapitating dolls of the French king and the Pope, and, by and large, Masonry – despite the widely varying character of its rapidly proliferating divisions and national branches – conduced greatly to the dissemination to the wider strata of society of Gnostic-Hermetic-Cabalistic occultism, illuminism, and the metareligious, perennialist ideas of *prisca theologia* as well as its rationalist offspring in the form of deism, anticlericalism, political radicalism, the cult of science and education, and various kindred radical ideas and isms, thereby paving the way for the French Revolution as well as for modernism in general. The watchword *liberté, égalité, fraternité,* whether Masonic in origin or not, succinctly sums up the spirit of Freemasonry and the Masonic intercourse across the social borders (see [Robe73] and [Pors98b]), reflecting the same Masonic taste for tinsel wisdom as the catchy bromide "science and progress" (some other rather chilling examples of the cheap wisecracks popular in the radical lodges, culled from the conversation of Benjamin Franklin, the leader of the highly influential Paris-based "philosopher lodge" *Neuf-Sœurs,* called the "UNESCO of the 18th century" by [Hans53] and often held to have played an important part – together with *Amis Réunis* – in the early phase of the French Revolution, are provided in [Faÿ61] p. 183 et seq.).

Additionally, Freemasonry was deeply implicated in the promotion of early industrialisation efforts and the agenda of scientific-technological "progress", to which it lent much of its own quasi-religious fervour. There is an intimate and enigmatic relationship between the British *Royal Society,* established in 1662 immediately after the Restoration, and early Freemasonry (see [Schn47] p. 11 et seqq.). For one thing, amongst the earliest members of the *Royal Society* were both sir Robert Moray and Elias Ashmole, the two first persons, whose initiations into speculative Freemasonry, in 1641 and 1646 respectively, have been recorded. Additionally, one fourth of the English Freemasons in the 1720s were also members of the *Royal Society* (see [Clar67] and [Nobl99] p. 74). The spiritual leader of early Freemasonry, the accomplished scientist, engineer, and inventor John Theophilus Desaguliers was also a fellow of the *Royal Society* and a close friend of its head, Isaac Newton, and it was the latitudinarian theology, perfectionist moralism, and rationalistic-deistic philosophy popular in these circles – i.e. largely the anti-papist and anti-sectarian agenda of "repressive tolerance" espoused by the whig adherents of "the Glorious Revolution" – that would become the characteristic spirit of Masonry (cf. [Clar65]). Propagating the new gospel of "science and progress", Freemasonry soon became extremely popular amongst men of science and engineering all over the world, and many schools of engineering were founded by Freemasons, such as the first American school of civil engineering *Rensselaer Polytechnic Institute,* the prominent Swedish school of engineering *Chalmers tekniska läroanstalt* (now *Chalmers tekniska högskola),* and most notably the prestigious *École Polytechnique* in Paris, the hotbed from which sprang Saint-Simon's and Comte's new *ersatz* religion of scientistic-positivistic socialism (see [Carl74], [Nobl99] p. 78 et seqq., [Army65] p. 37 et seqq. et passim, [Head49] p. 39 et seqq., and [Kinn43] p. 79 et seqq.).

1964 See [Clar65].

1965 On the Luciferian aspect of this rebellion, see [Coul92] p. 251 et seqq. Its basically Gnostic character was understood by well-informed contemporaries, such as Abbé Barruel, Condorcet, and Diderot (see [Barr73] vol. I p. 456 et seqq., [Cond66] p. 166 et seqq., [Dide1755], and [Gill95] p. 17). On the esoteric-gnostic currents of the Enlightenment, see, for example, [Faiv96], [Lamm], [Darn70], [Joha74], and [Neug99].

1966 See [Camu87].

known as 'free-thought', 'philosophism', 'eclectism'[1967], or 'ideology'[1968], naturally had to incorporate a motley mélange of ideas, partly taking the shape of a radicalisation – or, perhaps rather, perversion – of the Platonic-mystical-scientific agenda, with the moorings to Christianity now cut off, partly manifesting as a scattershot attempt to revive all kinds of heretical, ante-Christian, and anti-Christian strains of thought, which could be subservient to its rebellious purposes.[1969] Although there was never much uniformity to these anarchic strivings beyond the fundamental anti-Christian thrust and, at a closer analysis, they will break down into a multitude of factions, divisions, and individually held beliefs and views, two main tendencies may be distinguished, both grounded in the earlier divisions described in the preceding section, the one inclining towards excessive rationalism, positivism, and general anti-religious feelings and the other being bent on Romantic mysticism, occultism, and neo-paganism, although admittedly the division line between the two is far from always easy to draw.[1970]

In fundamental opposition to the Jewish-Christian perception of this world as God's creation and thus fundamentally good – at least in its original, prelapsarian form –, these new 'philosophers', just like the ancient Gnostics, declared the world to be in a bad state and in desperate need of repair and change. The so-called problem of theodicy, which in essence is but the same old Gnostic-Manichaean pessimism in philosophical disguise – was now much played up, soon becoming a cornerstone of the modern anti-Christian constitution, by which the benevolent Christian God, by a simple prestidigitatory gesture, can be relegated to non-relevance.[1971] As man by his very nature is a religious being, his heart naturally being intent either on the *visio beatifica* or on some substitute for it, and as only few will find much satisfaction in the quasiheroic emptiness of bald atheism, all kinds of new rationalist, deist, pantheist, moralist, or sentimental forms of religion or quasireligion started to crop up.[1972] While phenomena of this kind, such as Freemasonry and Mesmerism, aroused enormous interest amongst those disenchanted with the old and agog for something novel, others

[1967] Cf. [Dide1755].

[1968] This term was launched in the 1790s by Destutt de Tracy, who used it to signify his own sensualist-materialist approach to idea formation, "the part of zoology", which he wanted to substitute for traditional metaphysics (see [Bill80] p. 211).

[1969] In France, where the anti-religious feelings became particularly pernicious, Pierre Bayle consolidated the ideas of most of the continental strains of irreligion (Averroism, Alexandrism, libertinism, etc.) in his very influential *Dictionnaire historique et critique*, whereas Voltaire popularised the ideas of the English deists as well as a certain elaboration of Newtonianism slanted against traditional Christian beliefs. The printing press of course provided for the quick dissemination of all kinds of scandalous and sensationalist opinions.

[1970] On the 'Enlightenment' as a revival of paganism, see [Gay67] (cf. also [Manu59]), who, however, for all his learning and wit, tends to be altogether carried away by his own sympathies for the *philosophes,* becoming blind to the enormity and superficiality of their opinionated and arbitrary 'rationalism', heinous hate propaganda against the Christian religion and society, and contorted and self-deluding reliance on sophistry and derailed rhetoric. Be that as it may, the Enlightenment was not the first attempt to restore ancient paganism, but the entire history of Western Christianity can be construed as a series of increasingly vicious neo-pagan revivals, the most important of which will be the Carolingian Renaissance, the Renaissance of the 12th century, the Renaissance proper, the 'Enlightenment', Romanticism, and the 20th century neo-paganism of the National Socialists and the various other branches of neo-Gnosticism. [Gay70] attempts to survey the programme of the 'Enlightenment' philosophers under the title "the science of freedom", which, albeit *prima facie* perhaps an odd choice of header for what boiled down to the devastation of the spiritual heritage, from which we have the promise that "the truth shall make you free", and a wilful re-lapse into the bondage of paganism, nonetheless well sums up the rebellious pathos and ethos of this movement. As well made out in [Gluc80], the fairy tale of freedom as epitomised in Rabelais' description of the anti-monastery of *Thélème,* the utopia of the "fais ce que tu voudras" – a motto later fittingly adopted by the father of modern Satanism, Aleister Crowley (cf. [AW01] p. 188 et seqq.) –, is the prime founding myth of modernity, of which the true consequences were drawn out already by Thomas Münzer and the Anabaptists at the very outset of modernity. In fact, the sordid saga of Münster provides the paradigm of all subsequent attempts to realise such utopian dreams of heaven on earth, its Luciferian cult of freedom rapidly ending up in the communist abolition of private property and family bonds, unspeakable orgies, general anarchy, violence, terror, and carnage, and, as a *grande finale,* attempted self-destruction. Cf. also [Taub91] p. 106 et seqq., [Davi92b] p. 65 et seqq., and [Hane98a] p. 404 et seq.

[1971] See [Bill36], [Bill52], and [Walk72] p. 250 et seqq. As pointed out since the dawn of time (notably in the book of Job), man, being a finite, mortal being, whose understanding of the universe is by necessity severely limited, will hardly be in a position to adjudicate on such matters.

[1972] In Germany and some other Protestant countries, where the anti-Christian fervour was a little less blistering than in France, the new ideas sometimes came cloaked in trappings that *prima facie* looked Christian. Notably, the attempts to 'adapt' Christianity to the Enlightenment mode of thought – or its Romantic-Liberal descendants – perpetrated by Protestant liberal 'theologians', such as Semler, Schleiermacher, and Ritschl, in actuality, as pointed out by, for example, John Gresham Machen (see [Gres23] and [Gres22]; cf. also [Brow84] p. 432), boiled down to nothing less than the creation of another religion, to all intents and purposes different from Christianity, although retaining much of the outer forms and formulas of the Christian religion under the guise of a strangely duplicitous discourse that to the naïve may sound deceptively religious and, at times, even Christian. This new essentially sentimental-moralist religion constructed by German academics today dominates the Protestant churches of the principal non-Catholic countries with consequences, which, at least from a Christian point of view, can only be characterised as harrowing and appalling – or, perhaps, as God's judgement of Protestantism.

undertook to restore the cult of the ancient gods or demons[1973] or to create some kind of *ersatz religion,* replacing God with an idol to their liking, such as 'the great being', the nation, the people, the working classes, man, humanity, nature, science, utopian society, democracy, liberty, equality, women's rights, the perfect philosophical system, art, classics, nostalgia, or some other substitute for the divine.[1974] The prime prophet and self-proclaimed Messiah of modern technocracy and technoduly, Henri de Saint-Simon, even claimed that he in a nocturnal audition had heard God say that He had placed Newton at His side, conferred upon him the rule over the inhabitants of the planets, and instituted a "Conseil de Newton" of 21 elect – presumably scientists, engineers, and industrialists – to represent Him on Earth instead of the Church and the Pope.[1975]

Although the 'Enlightenment' philosophers often expressed a devotion to rationalism of heretofore unknown ferocity, there was something deeply irrational and close-minded in their parricide outlook, an overpowering lust to countenance only what they wished to be the case from their own hidebound anti-Christian starting-point, leading them into a Maelstrom of rash conclusions, abysmal distortions of reality, absurd pettifogging antics, and the most inane self-deceptions – faults still rampant amongst their various intellectual descendants! Similarly to the other waves of antinomian Gnosticism, the Enlightenment was also largely a libertine-hedonist rebellion of morals, and, as usual, the clique of self-styled spiritual-intellectual perfecti, investing themselves with the superb freedom from the shackles of conventional Christian morals, ended up in a sad abyss of moral corruption, lasciviousness, cynicism, cruelty, and bestiality. They excelled in the use of sophistic trickery and rhetoric inversions and delighted in all kinds of hidebound blasphemies, quibbles, and cynical paradoxes, letting no opportunity to find fault with Christianity pass. In particular, they made the witty ridicule and the guffaw their main weapons, horse-laughing out of court anything not to their taste. Handling the sword of the cachinnation and the arbalest of reckless mockery with great panache, they gleefully and bluntly espoused all the materialist and atheist errors so painstakingly refuted by the Christian apologists, they

[1973] In New Age and perennialist quarters, Jewish-Christian monotheism is frequently accused of having harmfully 'disenchanted' the world of its heathen gods and the various other supernatural powers that used to populate it. It should, however, be noted that these beings – whatever their ontological status – were already increasingly perceived as threatening, cruel, ridiculous, unethical, unsympathetic to man, and unworthy of true piety by the pagans themselves long before Christianity came into existence, as can be seen not only from the ample testimony of pre-Christian literature, where, just to give one example, such a devout author as Herodotus can assert as a matter of fact that everything divine is envious and instils disorder (see above p. 352), but also from the ease with which the devotion to these oppressive powers was eventually given up – and still is, wherever monotheistic religions evangelise. In fact, neither pagan religiosity, nor the Neoplatonic philosophers taking on the hopeless task of defending the old gods, but the state authorities of the Roman Empire, demanding participation in the cult of the emperor's genius, and the proliferating Christian heresies were the most difficult adversaries of the Christian church during its initial phase of rapid expansion. Nor did Christianity deny the existence of spiritual beings, such as angels, spirits, or demons, but generally viewed the old gods not as non-existent, but – quite similarly to the pagan view – as dangerous, demonic powers, of whom, in contrast to the old religion, it, however, brooked no worship. This is also the reason why the attempts to 're-enchant' the world by a revival of paganism by Romantics, National Socialists, and various New Age votaries arguably bear witness not only to eccentricity or naïveté, but to considerable imprudence. Additionally, far from disenchanting the world, classical Christian philosophy and theology viewed the world as enchanted by divine finality and all-pervasive symbolism, as filled with *vestigia Dei,* the traces of God's wisdom and providence, and as protected and cared for by God, His angels, and the saints, i.e. benevolent and generous Christian powers rather than the malicious demons of yore. In due time, this Christian enchantment of the world was to be undermined not so much by any tendencies inherent in Christianity itself as by the Ockhamist abolition of the depth of reality, which was soon to be followed by the abortive Renaissance attempts at a re-sacralisation of the world through a revival of various aspects of ancient paganism, as well argued by [McKn89] and [McKn92].

According to [Gay93], disenchantment is nonetheless to be regarded as a consequence of Jewish-Christian monotheism with its strengthening of man's personal consciousness, being much intensified by the Protestant emphasis on the conscience of the individual and the rejection of mystery, miracles, magic, and "religion" as instruments of mediation between the Divine and the individuals, but this disenchantment becomes deleterious, leading unto the modern/postmodern predicament of homelessness in the world only when the immanence of the personal, loving God implied by the Christian doctrine of the Divinity as a Trinity of Persons, who coinhere the Godhead in love, is given up for a deistic-unitarian conception of God as a unitary, impersonal, rationalistically conceived Being, far removed from both the created order and man. Thus, the often heard plea for a restoration of an archaic "sacred" cosmology or form of religiosity, which in its original, pagan form was always something taken for granted rather than something *consciously* opted for, ironically betrays a fundamentally Christian conception of man as a *person* who, following his own conscience, chooses his own ways before God. One may add that behind these clamours for re-enchantment also lurks the evolutionist conception of a progress from a sacralised, polytheistic primitivity via a semi-secular monotheist stage to a wholly desacralised modernity originally suggested by Hume, Comte, Frazer, and others devoted to the Enlightenment project of the deconstruction of religion in general and Christianity in particular. This evolutionist conception of religion has, however, been thoroughly discredited long since – for one thing, the prevalence amongst many of the most 'primitive' peoples of the world of what Wilhelm Schmidt called *Urmonotheismus,* a primordial monotheism with a conception of God largely reminiscent of the Jewish-Christian one, constitutes a major stumbling-block to it (see footnote 1528 on p. 314). Cf. also [Barf88].

[1974] See [Zamo99].

[1975] See [Roga92] p. 112. Cf. also [Bill80] p. 210 et seqq. and [RG87] p. 49.

boldly abolished not only Christianity and all religion, but also the human soul and its immortality, the other world with all its inhabitants, nay, even God Himself by some glib verbal conjuration, they tried by might and main to make the divine order of the world likewise disappear, although not very successfully until Charles Darwin at long last found the magic formula by which to conjure it away too, they flatly denied and prohibited the miracles and supernatural phenomena that threatened to make their materialist constructions tumble over and dissolve into dust, they delighted in shocking others by flaunting their own godlessness, moral turpitude, and radical ideas and proposals, although few, if any, of these would stand up to scrutiny or the test of reality, and they stupendously declared history to be an ever-lasting innerworldly progression the meaning of which – although indeed they generally despised the *causae finales* beyond all measure – was to pave the way for their own triumph – at the same time as they laboriously beavered away at the re-construction of the larger part of history as a nightmare of Christian darkness and superstition![1976] The Christian doctrine of the divine *logos* forsaken for the vagaries of nominalist and irrealist philosophy, be it the great paradox-maker Hume's sensualism, the *Allzermalmer* Kant's subjectivism, the positivist pontiff Comte's reductionism, or some other of all these isms that have ever since haunted philosophy, the world now lost its objectivity and full reality, becoming but a tinsel of flickers to be arbitrarily re-interpreted and re-constructed, or even denied or derided, according to anyone's whim or wish.

Notwithstanding that the first rush of modernity and liberation from the shackles of the supposedly outmoded Christian conscience so utterly despised by the Enlightenment wags came to an abrupt and blood-spattered end through the excesses of the French revolution, on which was to follow a Romantic-conservative reaction creating one of the longest spells of peaceful development in the history of our civilisation, all kinds of dragon's teeth had now been sown and were rapidly growing in the fertile and tolerant soil of Romantic hypocrisy, where they soon were to burst into the most gruesome bloom of nihilist, materialist, and atheist thistle and thorn. So, finally, the era of the apparently futile attempts to build a *civitas Dei* on earth drew to an end, and in its place the *civitas hominis* – Tage Lindbom's "människorike", the realm of man[1977] – was now about to be established, founded on the three pillars of modernity – science, technology, and the great chimera of the sovereign power of the people –, for which the naturalist metaphysics – or *ideology,* to use Destutt de Tracy's neologism–, including the "murder of God", the Darwinist myth of creation, and the flat denial of undesirable phenomena, such as miracles and conscience, provided the suitable and necessary foundation.

If the Luciferian phantoms of Reason, Revolution, and Science conjured up by this coven of profoundly disoriented gnostic prestidigitators today no longer looks like the great harbingers of enlightenment and ever-lasting happiness they were once promulgated to be, but rather strikingly more like the Erinyes of Divine vengeance sent to punish mankind by "strong delusion"[1978] for its pride, godlessness, cold heart, and wicked-

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[1976] In particular, Voltaire, Gibbon, and Hume initiated the tendentious, pugnaciously anti-Christian genre of history-writing, and ever since it has been popular in certain circles to trounce the Christian religion with all kinds of alleged iniquities – the crusades, the Inquisition, the witch-craze, the religious wars, anti-Semitism, the Galileo affair, nay even for such adiaphora as the medieval conditions of hygiene or folk superstitions. But this extremely biased historiography is both wide of the mark and self-defeating, insofar as it attempts to sling mud at the Christian religion *per se* rather than at the misbehaviour of individuals, who happened to live in a predominantly Christian era: Evil deeds will not be perpetrated – and indeed cannot possibly be perpetrated – in compliance with the Christian gospel of love, which in no wise brooks such misbehaviour, but only in glaring despite of it, as a consequence of the heartlessness, depravity, and sinfulness of man in his fallen state, whether he lives in a Christian society or not and whether he claims to be a Christian or not. Significantly, this state of affairs is in glaring contrast to the modernist ideologies, which grew from the Enlightenment agenda and which, heeding no divinely sanctioned standard, gave free reins to and frequently also directly fomented the most evil appetites of man – the ramifications of which have been all too well demonstrated in the Holocaust- and Gulag-ridden history of the 20th century.

Notwithstanding the Enlightenment historians' derogatory hatred of Christianity, the Christian religion and indeed the works of all previous philosophers, theologians, and other thinkers were treated even more arrogantly and overbearingly by Herder and the Romantics, who came to view anything not contemporary to themselves as unworthy of serious consideration, nay, as museum pieces to be compassionately understood as entirely conditioned by the time and place of their composition. In effect, this move reduces all former thinkers from potential discussion partners to animals in cages to be dispassionately studied by supercilious zoologist historians. In his *Screwtape Letters* [Lewi96c] p. 99, C. S. Lewis makes some amusing comments on the diabolical use of this "Historical Point of View", incisively summing up its purport thus, "To regard the ancient writer as a possible source of knowledge – to anticipate that what he said could possible modify your thoughts or your behaviour – this would be rejected as unutterably simple-minded."

[1977] See [Lind95].

[1978] *2 Ep. Thess. 2:11*

ness, for its having its "pleasure in unrighteousness"[1979], it may be interesting and instructive to contemplate how and why this terrible act of phantasmic theurgy came about. How are we to understand this *mutatio rerum,* this wholesale change in the climate of opinion, this unprecedented rejection of the Christian soul and nerve of the world's leading civilisation by a large portion of its own élite? Obviously, these men nourished a deeply felt grudge against Christianity, a grudge that they were also able to effectively propagate to many, both of their own contemporaries and of later generations. But where did this sudden bitterness come from? Was it, as many latter-day adherents of their new rationalist ways of thought will have it, the natural effect of a more critical approach to knowledge and new scientific and other discoveries? Or, was it perhaps just a more or less inexplicable fad or change in fashion? Is there not much truth in the argument put forth by some Christian controversialists that all this was fundamentally a sybaritic rebellion against the austerity of Christian morals, although we must be wary of confounding cause for effect?[1980] Certainly, there were also important political and social dimensions to these upheavals of thought, but were they really instrumental in the change itself? Ought we perhaps to look for explanations in a long-ranging trend of growth in state power, underpinned by secular theology and ideology, at the expense of the power of the Church and its Christian theology? Or shall we look to the arrival of capitalism and the growing importance of trade, technology, and industrialisation for an explanation? Shall we consider the rise of the middle classes as the real McCoy in all this? But must we not first ask what spiritual forces were at work behind these admittedly important developments? And what was the debt of the 'enlightened' rebels and revolutionaries to the lines of thought entertained in the Western 'underground' tradition of Averroism, Alexandrism, libertinism, free-thought, atheism, scepticism, and the like, to the succession of figures such as Pomponazzi, Machiavelli, Bruno Vanini, Hobbes, Spinoza, Bayle, and the English and Dutch deists? What was the true rôle of the ferment of Hermetic occultism, Gnosticism, derailed enthusiast or apocalyptic spirituality, mystical pantheism and illuminism, *prisca theologia,* neo-paganism, and Neoplatonism, which had been simmering *in petto* all since the end of Antiquity?[1981] And indeed, can we really expect to get at the real gist of this matter, which obviously is basically about a struggle between worldviews and, thus, from a Christian or religious viewpoint, about a struggle between spiritual forces, between "principalities and powers", by only considering innerworldly factors such as the aforementioned ones without *eo ipso* inordinately pre-committing ourselves to the agenda and emic viewpoint of the Enlightenment phenomenon, which we tried to understand and explain in the first place? On the other hand, how can this falling away from Christ be made sense of from a Christian perspective? What are we, for example, to make of the apocalyptic interpretations of these events popular in many quarters, i.e. the construal of them as the apparent fulfilment of the Biblical end-time prophecies about widespread apostasy, the workings of "the mystery of iniquity"[1982], and the arrival of "the man of sin", "the son of perdition; who opposeth and exalteth himself above all that is called God"[1983], the striking present relevance of which hardly can be denied even by the complete sceptic?

Whatever perspective we in the end settle for as the most revealing and elucidating, it cannot be denied that the Enlightenment bitterness against Christianity to some extent had its roots in the real or perceived faults of historical Christianity itself, although we must beware of naïvely accepting the polemical statements of the *philosophes* on these issues and the extremely tendentious, anti-Christian or generally anti-religious historiography, which was inaugurated by them, wrapping the art of writing history in a still opaque smog of disenlightenment, bias, and falsity. Albeit admittedly in no less need of reform and rejuvenation then than ever, the Christian Church was hardly in a significantly worse state at this point of time than it used to be. It is true that the heinous religious wars of the post-Reformation era had a greatly dispiriting effect on the Christian world, which certainly could be capable of fomenting anti-religious sentiments in some, but only the most naïve observer could fail to see that these distressing internecine fights in actuality had very little to do with the genuine Christian religion at all, but in reality masked all kinds of power struggles of a national, political, economical, and social nature and rather than being attributable to too much Christian piety lay bare the dreadful ramifications of the lack of such piety and the disregard for the Christian gospel of love amongst both the powers that be and those who struggled to take their place – or to speak the language of religion, the

[1979] *2 Ep. Thess. 2:12*

[1980] See, for example, [Jone93], [Jone94], and [Jone95a].

[1981] See [Bill80] p. 86 et seqq. for a superb discussion of the occult origins of the revolutionary faith.

[1982] *2 Ep. Thess. 2:7*

[1983] *2 Ep. Thess. 2:3-4*

sinful pride, greed, and envy that reign fallen, unregenerate man. If it is true that the Christians churches themselves by their temporal leaders' and members' human failings, the intermittent faults and decadence of some of their institutions, and their apparent lack of success in fundamentally reforming society and mankind – clergy as well as seculars – so as to live up to the standards of the gospel at times managed to obfuscate the essential religious core of Christianity, they were certainly not the monstrosities that the Enlightenment philosophers and their spiritual descendants tried so hard to make them look like.

Nonetheless, it cannot be denied that Protestantism in many ways paved the way for the Enlightenment, just as Ockham had paved the way for Protestantism, nay that the Enlightenment largely is to be construed as a radicalisation of the programme of the Reformers and yet another step on the road of nominalism, reductionism, and subjectivism, on which Ockham had so eventfully set out. When the Protestant Reformers, in the professed attempt to restore and cleanse Christianity from the dregs that had accumulated through the ages, ventured – leaning on the slippery fulcrum of caesaropapistic greed – to replace the authority of the Roman Catholic Church and the Christian tradition with that of *sola fide* and *sola scriptura*[1984] – interpreted more or less by the caprice of the exegete rather than in accordance with the established hermeneutical practices of the *quadriga* – they not only fell back on arbitrary, arrogant, and violent ways of arguing their cases that in many ways prefigure the disingenuous sophistry and acerbic rhetoric of the Enlightenment philosophers, but they also opened the door to the untrammelled subjectivism and narrow-minded and supercilious rationalism, which would steadily be in the ascendant in philosophical and theological discourse during the centuries to come. Predictably, subjectivism, which is the very essence of heresy, every so often fanned with the pride of derailed enthusiasm[1985], was also very soon to break Protestant Christianity up into innumerable warring sects – some of which escalated the programme of reformation beyond all measure and ended up in the most extreme gnostic standpoints, if not outright anomie, anarchism, and atheism – at the same time as it helped the hydra of delirious rationalism to grow an ever-increasing abundance of heads, one of the more formidable of which was the Biblical criticism more or less urged into being by the formula *sola scriptura* and forged into an art of unhampered rationalist subjectivism by Hobbes, Spinoza, Simon, Semler, Reimarus, and their likes[1986], and still rearing its head zestfully amongst academic Protestant theologians, as seen, for instance, in the controversies surrounding the absurd legerdemain of the so-called Jesus seminar. By arbitrarily scrapping Christian doctrines they for one reason or other found suspect, such as the purgatory, the transubstantiation of the bread and wine of the Eucharist, or the need for good works, and such essential buttresses of higher religion as saints, miracles, and monasticism – and this despite their scriptural foundation –, they not only made Christianity look skewed, austere, theoretical, and poor in true spirituality – as was also perceived by many of the more sensible Protestants, such as the Cambridge Platonists –, but made the option of giving up the rest of Christianity as well look an increasingly viable option.[1987] By condemning in the most violent tirades the larger part of Christian history as a well-nigh worthless spell of popery and superstition, they made Christianity itself seem doubtful and superstitious and blazed the trail for the contorted anti-religious propaganda of the Enlightenment.

Ockham's nominalism, the Reformers' Protestantism, the Enlightenment philosophers' shallow rationalism, and so many other influential philosophical currents of the last eight centuries (and, in particular, of the last three), all evince a common 'gnostic pattern' of a strong subjective sense of the radical evil of the current state of affairs, of an attempt at a sharp break with this state and the past that had produced it, of the frenzied espousal of novel, extreme, and fantastic positions, sentiments, and obsessions, of the obfuscation of likely truth through intemperate rhetoric or twisted arguments, and of a strange atmosphere of intellectual duplicity,

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[1984] The fundamental paradoxicality of this view is underscored by such Scriptural passages as *Ep. Jac. 2:14-26,* where the epistler tells us (2:24), "Ye see then how that by works a man is justified, and not by faith only." Cf. also *Ep. Tit 3:10-11*.

[1985] On the importance – and difficulty – of discernment in the spiritual life, see [Duba97].

[1986] See [Frei74]. Albert Schweitzer in his survey of the *Leben Jesu* research [Schw21] famously pointed out how the different 'historical Jesuses' re-constructed by innumerable liberal theologians and atheologians in actuality only reflect and cater to the scholars' preferred opinions of Jesus – i.e. their personal love, hatred, respect, or contempt for Him – rather than bring us a whit closer to the real 'historical Jesus'. The hollowness of some of the rationalist assumptions, on which Biblical criticism rests, such as the principle that all examples of correct prophetical forecasts are to be explained as *vaticinia ex eventu,* will be evident to anyone with only a passing knowledge of the paranormal. If it was possible for Morgan Robertson to publish the book *Futility* in 1898 (see [Robe98]), in which he describes the calamity of *Titanic* in great detail almost 15 years before it happens, the rationale for the currently most common datings of the gospels and the *Book of Daniel* as well as the division of Isaiah into two (or even three) Isaiahs falls flat. See also [Kemm25] and [Arch82].

[1987] Cf. [Berg90b] p. 111, who aptly characterises Protestantism as a "radical truncation" of the rich Catholic universe.

militancy, and morbidity.[1988] This is in stark contrast to the temper of orthodox Christian theology and philosophy up to 13th century – and indeed to most traditional Catholic theology and philosophy (and, at least partly, to some Protestant thought as well, such as Lutheran orthodoxy at its best or the Scottish common sense philosophy) to this day –, with its reverence for the accumulated wisdom of the past, its humble sensibility and open-minded thoughtfulness, and its earnest, systematic, and probing quest for the truth, as splendidly epitomised in the grand syntheses of St. Augustine, St. Bonaventure, and St. Thomas Aquinas. Obviously, this modern 'gnostic pattern' once again brings us back to Eric Voegelin and his ideas on the importance of the gnostic thought structures in the shaping of the larger strokes of the intellectual history of our civilisation. We will later take a closer glance at the concept of *immanentisation,* which not only is a crucial element in Voegelin's conception of history, but arguably its most interesting and thought-provoking contribution to the understanding of our intellectual past. But before doing so, we will have to consider the thorny question of the roots of the impetuous Faustian spirit of the West, of the Western science and technology, which today, rather than Christianity, seems to be the preponderant spiritual force of our civilisation. Is this spirit the fruit of rationalist anti-Christianity, as has been plausibly claimed by historians of a modernist or positivist bent all since the Enlightenment, or is it a great Christian achievement, as has been suggested by some eminent Christian scholars? Or are both these camps mistaken, having been misled by their own prejudice and wishful thinking?

[1988] Notably, some Protestant theologians have believed themselves able to discern a kind of proto-Protestantism in one or other of the ancient or medieval gnostic heresies. See [Stro96b] p. 152.

3.3.7 EXCURSION: SOME REFLECTIONS ON THE WHITE THESIS

> *We would seem to be headed toward conclusions unpalatable to many Christians. Since both science and technology are blessed words in our contemporary vocabulary, some may be happy at the notions, first, that, viewed historically, modern science is an extrapolation of natural theology and, second, that modern technology is at least partly to be explained as an Occidental, voluntarist realization of the Christian dogma of man's transcendence of, and rightful mastery over, nature. But, as we now recognize, somewhat over a century ago science and technology, hitherto quite separate activities, joined to give mankind powers which, to judge by many of the ecologic effects, are out of control. If so, Christianity bears a huge burden of guilt.*
>
> *I personally doubt that disastrous ecologic backlash can be avoided simply by applying to our problems more science and more technology. Our science and technology have grown out of Christian attitudes toward man's relation to nature which are almost universally held not only by Christians and neo-Christians but also by those who fondly regard themselves as post-Christians.*
>
> *Lynn White*[1989]

Why did science and technology as we know them emerge in the Christian Latin West rather than in, say, the much-celebrated splendour that was ancient pagan Greece, Rome, and Persia, under the crescent of Islam, the culture which provided the Latin West with both the model of the university and with so much (proto-)scientific knowledge, amongst the learned and inquisitive scholars and mathematicians of Hindoo and Buddhist India, in the Confucians' and Taoists' China, the mother of so many inventions, amongst the Orthodox Christians of the Byzantine Empire, where so much of the legacy of ancient knowledge was always readily available, or in some other of the great cultures of our planet? Whereas many of the early historians of science – still being under the spell of the Enlightenment deprecation of the Christian Middle Ages as an age of almost total darkness and hideous superstitions and that positivist Old King Charles's Head of scoffing at Christianity as the grand foe of science and progress at any opportunity – were unable to explore the possible answers to this question in an unbiased and open-minded way, all since the beginning of the last century the 19th-century grand myth of "the warfare between science and theology"[1990] has been piecemeal pulled down and today it is generally acknowledged that science was born in the Christian West for a reason, as "the continuity thesis" has replaced the "warfare myth" of yore.[1991] The perhaps foremost pioneer in exploring these issues and exploding the warfare myth was Pierre Duhem, who in the early 20th century put together his landmark studies on medieval science, uncovering the work of the Ockhamist Schoolmen, in particular John Buridan and Nicole Oresme, who, inter alia, anticipated already in the 14th century much of Galileo's kinematical discoveries.[1992] He also famously argued that the birthday of science was the day in 1277, when the Paris bishop Étienne Tempier issued his condemnation of various theologically exceptionable doctrines, including the idea that there exist limitations to God's creative freedom and the astrological theory of the great year with its cyclical-deterministic conception of history, thereby unwittingly paving the way for the unprejudiced scientific investigation of nature and the linear-progressivist understanding of history that undergirds scientific progressivism. At about the same time as Duhem explored the Christian roots of science, Max Weber tried to explain the spirit of Western capitalism and progressivism as an effect of Protestant, in particular Calvinist and Puritan, ethics, reding the intense innerworldly activism typical of the Western *modus essendi* as a transformation of traditional Christian asceticism through the adoption of the kind of Calvinist and Puritan ethics, in which

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[1989] [Whit67]

[1990] This expression comes from the title of [Dick1899].

[1991] The literature on the relationship between Christianity and Western science and technology has grown intractably. Some valuable contributions are [Knel12], [Duhe13], [Whit29], [Fost34], [Fost35], [Fost36], [Mert62], [West58], [Webs75], [Ovit87], [Cohe90], [LN86], [Funk86], [Hooy73], [Klaa77], [Turn98], [Leeu64] p. 324 et seqq., [McEv82] p. 206 et seqq., [Jaki78], [Jaki90], [Jaki00] p. 47 et seqq. et passim, [Broo91], [Howe02], [Glac76], [Whit67], [Whit78], [Whit90a], [PT94] p. 17 et seqq., [Cohe94], [Nobl99], [Benz89], and [Benz65] p. 135 et seqq.

[1992] Duhem's findings were published in the monumental *Le Système du monde* [Duhe13]. Another influential attempt to prove the importance of Christian scientists for the development of science was made at about the same time by Karl Kneller (see [Knel12]).

worldly success becomes the confirmation of divine election.[1993] Also of great importance for the popularisation of the argument that Jewish-Christian ideas were instrumental in midwiving science were the Lowell Lectures held by A. N. Whitehead in 1925, later published as *Science and the Modern World.*[1994] According to Whitehead, the project of science is predicated on the belief in the rationality of God inherited from medieval theology. Additionally, he paid particular homage to the Benedictines as the precursors of modern science and technology by virtue of the interest they took in the workings of nature, portraying the monasteries as the early hotbeds of technological development – an idea that has since gained widespread popularity.[1995] Similarly, Michael Foster in a number of influential articles in *Mind* authored in the 1930s advocated the idea that the modern conception of nature was founded on the creationist natural theology of Christianity as opposed to the pre-modern, teleological conception of nature espoused by the Aristotelians.

Whereas Christian scholars and scientists struggled hard to prove such points to the largely inimical, predominantly anti-religious academic establishment during the first part of the previous century[1996], in the 1960s this very argument, now having been rather widely accepted as established fact, at least amongst the cognoscenti[1997], of whom some even had begun to hail the Middle Ages as the first Industrial Revolution[1998], was all at once turned on its originators, as, under the influence of the rapid growth of environmentalist and ecological concerns, the climate of opinion as regards science and technology suddenly acidulated. In 1967, in an extraordinarily influential article, somewhat oddly published in *Science,* Lynn White, himself a leading revisionist explorer of the technological progress of the Middle Ages, claimed that the Bible was the ultimate cause of our current environmental plight and of the increasingly berserk gallop of science and technology, by virtue of[1999]

- endorsing man's dominion over nature and fomenting the voluntarism typical of the West through the anthropocentric account of the creation in Genesis, where man, *qua* the image of God, is depicted as the final goal and appointed master and subduer of the created world, the sole purpose of which will be to serve man

[1993] See [Webe34]. One may, however, question whether such an eye-catchingly and obnoxiously anti-Biblical conception of worldly success really was ever widely accepted even amongst strict Calvinists, diligent Bible-readers as they were. Another famous investigator of the connections between Puritanism and early science was Robert Merton – see, for example, [Mert62] and [Cohe90]. Cf. also [Hooy73] p. 98 et seqq.

[1994] [Whit29]. As pointed out by [Maur83] p. 263 and [Fort95] p. 212, already Nietzsche construed science as a kind of parricidal parasite on Christianity, a new metaphysical faith that had rejected its Christian mother. [Fort95] astutely adds: "Nietzsche's analysis is particularly valuable insofar as it brings to light the hidden premise of Whitehead's position: in a world that considers reason to be superficial, denies that there is any part of human being that is not intrinsically dependent on matter, and claims to have replaced the "will to truth" with the "will to power", the foundations of everything become by definition non-rational or "religious" in the Nietzschean sense. All "values", science included, originate in the mysterious or godlike recesses of the self."

[1995] For example, similar themes are explored in [Fisc69] and [Mumf55] p. 12 et seqq., of whom the latter famously associated the invention of the mechanical clock with the regularity of monastery life. It should be noted that the Benedictine principle of "ora et labora" does not necessarily imply a high valuation of manual labour *per se.* On the contrary, manual labour was in the early Middle Ages usually seen as servile and humiliating, a penitential instrument and the punishment of mankind consequential upon the Fall of Man. Only in the High Middle Ages, a more positive appreciation of work began to emerge, over the causes of which there is no scholarly consensus. The debate on the medieval attitudes to manual labour is briefly surveyed in [Whit90a] p. 11 et seqq., who also calls attention to the fact that positive attitudes to work – for example, celebrating man as *homo faber* – were not totally absent amongst the ancients, as is sometimes claimed, but were cultivated in certain quarters, notably amongst the Stoics. These attitudes, which, albeit ultimately going back to Posidonius and Panaetius, entered the works of St. Augustine via Cicero, wielded, through the Bishop of Hippo, a significant influence in the Middle Ages. See also [Ovit87] p. 88 et seqq., p. 164 et seq., p. 199 et seqq. et passim, where the fundamental ambiguity in the medieval attitudes to work is strongly emphasised, but nevertheless a major change during the High Middle Ages in these attitudes, referred to by the author as "the secularization of labor", is spotted, as a new "conception of labor divorced from personal or communal spiritual goals, a conception that cleared the way for an emphasis on productivity and profitability at the expense of the Benedictine ideal of an edifying subsistence economy", slowly emerged (id. op. p. 201). Other important works on this topic are [Chen97] and [LeGo82].

[1996] On the antagonism that met Duhem and the publication of his work, see [Jaki84] and [Jaki85].

[1997] So, for example, in Herbert Butterfield's influential book on the origins of science [Butt60].

[1998] So [Gimp77].

[1999] [Whit67]. He further develops his ideas in some of the essays collected in [Whit68] and [Whit78]. Cf. also [Whit62]. Good surveys of the debate and literature on White's ideas are found in [Derr75], [Attf83], [Fort95], [Gray94], [Whit90a] p. 1 et seqq., and [MG84] p. 373 et seqq. Cf. also [Monc70], [Maur83], [Sabr88], [Hood92], [Huff93], [Ferk93] p. 119 et seqq. and p. 133 et seqq., [Cohe94] p. 378 et seqq., [Grun55] p. 111 et seqq., [Sayi58], [Sayi60] p. 407 et seqq., [Saun63], and [TG94].

- disenchanting and desacralising nature by driving out the spirits, demons, and *genii loci,* who used to occupy it, lending to the landscape a sacredness protective against the kind of reckless exploitation and demolition characteristic of modern times, and instead replacing this sacralised universe, where man was part of nature, with a stark anti-animistic dualism between soulful man and soulless, disenchanted nature, where even the animals could be regarded as automata and treated accordingly
- depicting history as a progression towards a goal according to a divine plan, ending up with the establishment of the kingdom of God, thereby attaching an importance to historical events and activities absent from other cultures, which look at history as a repetitive cyclical process or do not care much about history at all

In order to explain why science and technology did not develop in Eastern Christianity, which by and large shares the same Christian worldview, White opposed the contemplative intellectualism of the Greek East to the activist voluntarism of the Latin West – and in particular of Western monasticism, although he also implied that the Christian activism had its ultimate roots amongst the Jews with their prophetism, Messianism, and understanding of themselves as the 'chosen people'.[2000] So, according to White, the Greeks held sin to be a kind of intellectual error or blindness and the way to salvation to go through orthodoxy, that is to say intellectual illumination, whereas the Latins regarded sin as a consequence of a corrupt will and held salvation to be found in right conduct. After this rather doubtful distinction[2001], White, describing himself as a "churchman" – albeit evidently one who, when he saw himself hoisting with his own petard, had the courage to face the consequences squarely – concludes that in order to find guidance out of our current predicament we should look to Hinduism, Zen Buddhism, and St. Francis, whom he makes out as a panpsychist crypto-Cathar teaching us modern environmentalist concern for nature – although White earlier in his career had made the same saint's positive interest in nature – i.e. his preaching for the birds and upbraiding a wolf for unnecessary bloodthirstiness – foreshadow the scientific interest in nature.

The debate amongst historians, theologians, environmentalists, and others concerned subsequent on the brisance of White's missile largely followed the predictable course, the responses and comments reflecting the different observers' metaphysical predilections, be they of a religion- Christianity-, technoscience-loving or -hating disposition. For environmentalists, liberal theologians, New Agers, and radicals of different shades, White's message was of course grist to the mill, strengthening them in their belief that (orthodox) Christianity needed to be replaced with something spiffier.[2002] Those embracing scientism and positivism, if taking notice at all, generally resented being lumped together with the Christian archenemy – as much as orthodox Christians resented being pilloried for an ecological crisis that, at least from a commonsense point of view, rather looked like the ultimate upshot of the anti-Christian Enlightenment agenda of atheistic contempt for the life of the spirit and unbounded idolatry of the national state, politics, power, money, science, technology, the laws of nature, the Aryan race, the working class, or some other false god.[2003]

[2000] Cf. also [Whit68] p. 43 et seq. [Gean66] and [Sher95] provide two other comparative studies of Latin Catholicism and Byzantine Orthodoxy.

[2001] For one thing, St. Thomas, the arguably most influential of the Latin theologians, viewed sin as a kind of intellectual error rooted in a lack of proper understanding. Although Duns Scotus, as always, advocated the view contrary to St. Thomas's, regarding sin as a corruption of the will, he certainly did not hereby imply that doctrinal error was to be connived at, nor did the Eastern Orthodox Church – or St. Thomas, for that part – hold morally responsible activity to be unnecessary, if only orthodox doctrine was paid lip-service to. See [Pilt78] p. 197 et seqq. and p. 226 et seqq.

[2002] Writings where such opinions abound are, for example, [Ferk93] and [TG94]; more of the kind is discussed in [Derr75]. The absurdity of the "calls for the resuscitation of archaic cosmology" is adverted to in [Gay93]. [Gray94] surveys various, partly rather curious, theological responses to White's thesis.

[2003] In fact, White suggested many other possible causes of the Faustian mutation of the West. [Derr75] p. 42 enumerates some of these: "White has also argued, variously, that the unique acceleration of technological progress in the West was due in part to agricultural changes leading to altered social structures; to "Celtic cultural genes" which took pride in artisanship; to the psychological shock of barbarian incursions, disposing the mind to receive and use new ideas and forms; to Christian opposition to animism, ending the old mythological subservience to the cosmos and making nature amenable to human work; to the Western Church's battle against the Cathar heresy, with its dualistic devaluation of the material world as the creation of an evil god; and to a religious quest for labor-saving devices as humane."

Apart from the question of gratifying our own pet notions, whatever these may be, what are we to make of this? Are we to blame Christ for the ecological crisis, or our Father in Heaven, or perhaps the Holy Ghost, or even Moses and the Jewish people? However arresting and alluring White's tract for the times may have appeared in many quarters at the time of its publication, is there not something inherently absurd and fantastic about his thesis and even an unprepossessing streak of academic sensationalism in his odd renegade paradox-making? Does Christianity, amongst its own adherents generally understood as the religion of love and meekness, really teach us that we are to seek happiness in this world, that worldly wisdom such as that of science is of great merit and importance, or that we are entitled or even expected to exploit and maltreat our neighbour, poor animals, and nature in its entirety as well? Did Christ instruct us to lay up for ourselves treasures upon earth? Did He assure us that His kingdom was of this world and that we must build aeroplanes, submarines, and supercomputers to prove it? Certainly not! Rather, the early Church, if we are allowed to take our cue from it as in some sense uniquely close to the original Christian kerygma, was absorbed in the life of the spirit – questions of salvation, ethical conduct, martyrdom, personal sacrifice, charismatic gifts, good works, and suchlike – but showed little interest in or outright contempt for worldly wisdom, be it science, engineering, or jurisprudence, as can be seen in the recurrent polemics against *vana curiositas*[2004], which was held to incite *superbia,* pride, the first and worst of the seven deadly sins. By and large, Christianity seems to have adopted the same attitude of kainophobia and general indifference and scepticism about technology as ruled pre-Christian Antiquity, only reluctantly giving its approval to novel technology, if it was obviously good and just.[2005] If the New Testament has extremely little to offer in support of White's ideas, are we then – with the ancient Gnostics and other anti-Semites of all times – to put the brunt of the blame on the Old Testament and the Jews instead? But not even the dauntless Prof. White ventured to contend that the Jews of old were zealous scientists and engineers. In fact, as we will try to explicate below, the alleged connection between the scandalously heavenly-minded, uncompromisingly theocentric ethos of the Abrahamitic religions on the one hand and, on the other, the innerworldly and anthropocentric power-orientation and manipulative Svengali mindset typical of modernity, be it in its scientific, technological, or political appearances, to say nothing of the disastrous environmental backwash consequent upon the modern agenda, seems problematic and tenuous in the extreme.

Firstly, White's emphasis on the importance of the idea of man's dominion over the creation seems to be moulded on Francis Bacon's idiosyncratic adaptation of the first chapter of *Genesis* for his own propagandistic purposes[2006] rather than on a close reading of the text of the relevant Biblical passages themselves – i.e. the narratives dealing with the Creation, the Fall, God's curse on the earth, the subsequent antediluvian history, the Flood, the Tower of Babel, and the different covenants God made with the Jewish patriarchs – or a study of how these have been interpreted in Christian exegesis through the ages.[2007] In fact, such a study would have shown the true tendency of the starting chapters of *Genesis* to be entirely at odds with Bacon's whimsical misconstrual, which White so rashly embraced, but hardly any reasonably attentive Bible-reader, let alone any orthodox Christian theologian would accept. Whatever the deeper purport of the story of the Fall, it can hardly be made out to convey confidence in man's capability to judiciously administer the earth, and antediluvian history consequently associates technical-cultural impetuosity with the blameworthy and bloodstained descendants of Cain, against whom Set's praiseworthily pious and peaceful offspring is contrasted.[2008] Neither does it seem fair to say that the Biblical view of man as special, superior, and created in the image of God is unique to the Bible. That man is an orderer and changer of nature and through his special endowments surpasses the members of the animal and vegetable kingdom will be a universal observation, simply because it is an obvious fact of life and because we, *qua* humans, naturally look at the world from our own, admittedly somewhat parochial, standpoint rather than from the vantage point of frogs, birds, ferns, or cockroaches. Some theologians, taking their cue from the many Biblical passages that express awe and marvel at the majesty of God's Creation and the stunning wisdom displayed therein, have responded to White's rebukes by emphasising the idea of man's "respectful stewardship of an earth which belongs only to God" as much more Biblical

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[2004] See footnote 1941 on p. 416 above.

[2005] Cf. [Ellu64] p. 32 et seqq.

[2006] So also [Fort95] p. 216 et seq.

[2007] One valuable study of this topic is [Will48].

[2008] See below p. 516. See also [Ellu84a-b].

and Jewish-Christian than the Baconian-Cartesian travesty.[2009] But also this *prima facie* appealing notion of responsible stewardship will convey a far rosier and far less realistic picture of man's capability for the good, right, reasonable, and wise than what can be gained from the study of the Biblical narrative or from traditional Christian theology, according to which the *corruptio haereditaria* and its consequences, that is to say the *maculum* and *deformitas naturae* adhering to fallen man all since the perpetration of the original sin, impart on man an *impotentia bene agendi* that can only be overcome by the grace of God. Thus, we are not to expect man to be able to comport himself with the responsibility needed for this stewardship, and in particular not so unless he seeks refuge with and help from God.

Secondly, the point of the Jewish-Christian "anti-animism", i.e. the denunciation of all kinds of idolatry, demonolatry, necromancy, theurgy, and suchlike and the revulsion at the abominations often involved in these activities, is certainly not to set man free to bulldoze nature, cut down beautiful groves, dam up purling brooks, and cover the face of the earth with asphalt and concrete. In the view shared by all the Abrahamitic religions, the Molochs, Baals, dryads, fairies, Robin Goodfellows, and various other lesser divinities, demons, spirits, etc. are simply false gods, possibly harmful to commune with and certainly unworthy of man's worship, piety, and deeper concern, which should be reserved for the living, real God, the Creator of the grandeur of Heaven and Earth. Arguably, because God's creation is recognised as such, it does not get less sacral or less worthy of attentive care and protection, but rather more so, let alone does man become entitled to ride rough-shod over it. That this Christian "anti-animism" really does not imply a denial of the spiritual presences in nature at all can also be gathered from, for example, St. Augustine's dictum, "Every visible thing in this world is put under the charge of an angel."[2010] And although human activities caused ecological problems already in the Middle Ages[2011] and, indeed, have done so in all ages, these problems hardly have anything to do with Christian "anti-animism".[2012] These pre-modern environmental issues, albeit largely a result of increasing industrial activity, will also be fundamentally different from the ecological-environmental catastrophes of modern times both in magnitude and character, being brought about inadvertently and, thus, deriving from a lack of foresight and proper understanding. Such lack of insight, deplorable as it was, is poles apart from the systematic and brutal application of the neo-gnostic insensibility to – or perhaps rather total contempt for – the divine splendour and beauty of nature and the suffering of other sentient beings, an insensibility unalienable from the modern rebellious overturn of the esthetical and ethical norms grounded in the divine Logos and from the modern monomaniacally exploitative-utilitarian mindset – Heidegger's *Ge-stell,* the view of nature as nothing but *Bestand,* resources, to be recklessly utilised to one's own advantage in the maelstrom of restless activity that makes up the modern world[2013] – of which the archetypal spokesman was Francis Bacon[2014] and of which the large-scale adoption starts only with the 18th-19th century Industrial Revolution, as Christianity, at least in its more orthodox forms, had already lost its grip over the intellectual élites, which now instead bowed down before the great idols of "progress" and "man".

Additionally, the breakthrough of modern science was in fact, as pointed out by Stephen McKnight, accompanied not only by an anti-animistic thrust towards *Entzauberung,* disenchantment, but also by a major attempt to "sacralise the secular", through *prisca theologia* and the closely allied occult pursuits so rapaciously engaged in by the early scientists-magi.[2015] By making man a terrestrial god, society a utopian paradise on earth, or at least a potential Eden, and nature the emanation or panpsychical expression of God, more or less identical to Him, this endeavour of sacralisation, however, in the end helped to make the sacral and secular indistinguishable and, thus, reinforced rather than alleviated the secularising, immanentist impetus, which soon was radicalised into the anti-theistic cult of man and progress constitutive of modernity. Thus, the animist-panpsychist medicine White and many of his environmentally concerned followers recommend will, according to McKnight at least, be the very miasma that in the first place caused the disease they want to cure!

2009 [Derr75] p. 43. So also Jacques Ellul in [Ellu84b]. See also [Gray94] and [Attf83].

2010 Quoted from [Davi71a] p. 12.

2011 See [Gimp77] p. 75 et seqq. Amongst the main medieval problems were deforestation, water pollution (mainly caused by tanning and slaughtering industries), and air pollution caused by the burning of coal.

2012 See [Monc70].

2013 [Heid74]

2014 [Attf83] p. 381 points out that also Descartes' attitude was partly similar to Bacon's.

2015 See below p. 444.

Thirdly, the Messianic-Apocalyptic notions, which constitute such an essential part of the Abrahamitic religions, will, when taken seriously, undermine rather than underpin the preoccupation with thisworldly pursuits and, in particular, with the construction of technological or political utopias in this world. If the Second Coming may happen at any moment, it will indeed be exceedingly foolish to plod away at the laying-up of treasures upon earth or at the pursuit of this or that vision of the perfect society rather than to work on the salvation of one's own and others' souls. And if one expects soon to see a new heaven and a new earth come into being and the first earth to pass away, it will be utterly insensible to devote oneself frantically to the pursuit of progress, the relief of man's estate, or the reformation and betterment of the current, fallen world. Although the 20th chapter of *The Revelation of St. John* indeed forebodes that before the end of the world the saints will be resurrected to live and reign with Christ for a thousand years and although the interpretation of this millennialist passage has always been tantalisingly contentious amongst Christian theologians, the prophecy, even in the most literalist construal of it as concerned with an innerworldly Messianic kingdom of happiness filled with earthly delights, cannot possibly be made out to say that man is himself to bring about the millennium and the pleasures expected to accompany it.[2016]

But is there not in the Abrahamitic religions a streak of belligerent activism, as epitomised by the concept of "holy war", a violent pleonectic voluntarism cloaked in religious language, being particularly perspicuous in the Messianism and Apocalypticism of these religions? Did not the ancient Jews attack the land of Canaan with great violence and slay the Canaanites without remorse, thereby giving expression to an intemperate nationalist voluntarism and inaugurating a long tradition of religiously motivated aggression that easily can be extended to nature as well? Such accusations are often heard today, but hardly can the Jewish 'national' activism as described in the Old Testament be construed as voluntarist, except insofar as the Jewish people regarded itself as the instrument of the *divine* will, to which it indeed, according to the Biblical narrative at least, proved a most contumacious and unwilling servant. If being such a tool of the divine will and a pawn in the history of salvation is to be described as 'voluntarism', this is not voluntarism in the usual anthropocratic acceptation of the word, to wit as an urge to have one's own way, but only in a theocratic sense contrary to the usual one, to wit as a compulsion or obligation to obey the will of God.[2017] Christianity certainly can be characterised as even more radically anti-voluntarist than Judaism, making self-oblivion and unselfish service of God and of one's neighbour the hallmark of righteousness, as also underscored by Christ's apolitical and anationalist conception of His own rôle as the suffering Messiah, who takes on Himself the sins of mankind, laying down His own life for His friends.[2018] Thus, if an undue voluntarism, showing in acts of aggression, can be blamed upon Christians, as will indeed occasionally be the case during the course of history, this will be *despite,* rather than *due to* the gospel of peaceful love and redemption preached by Christ, the consequence of the Christians' human failings or sinful unwillingness to obey the instructions of their divine Master. Only late, did a kind of political-nationalist Messianism that can more correctly be branded voluntarist, insofar as it was exploited by a few Messianic pretenders and adventurers to promote their own bellicose projects, make itself felt amongst the Jews, fomented by the wrongs the Jewish people suffered during their time of subjection to the Roman Empire, but perhaps also, to some extent at least, feeding on the rancour cultivated in certain Jewish quarters against the otherworldliness of the Messianic kingdom proclaimed by Christ. As for Islam, the

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[2016] The advocates of so-called *postmillenarianism* popular in some circles during the 19th century tried to do exactly this, supposing that man by his own efforts was to develop a thisworldly kingdom of happiness through "progress" before the Second Coming of Christ. In the Biblical text, there is of course at best extremely scant support for this interpretation, which rather reflects the progressivist mania that betook the world during the Enlightenment and still was at its heyday in the 19th century. The more conventional *premillenarian* interpretation takes the text at face value, holding that the Second Coming and the first Resurrection (of the saints) will anticipate the Messianic age of the millennium, which will be followed by the second Resurrection (of non-saints), the Last Judgement, and the end of this world. *Amillenarianism,* advocated by, for example, St. Augustine, Luther, and Calvin, construes the text allegorically as an allusion to Christ's and his saints' rule of the Church for a very long period, which in prophetical language may, it is contended, be denoted by the expression "a thousand years". As to the general chronological fixation of the events described in the *Apocalypse,* a distinction is made between *futurists,* who hold that these events will happen in the future, *historicists,* who contend that they are currently unravelling within history, *symbolists* (or *idealists),* who believe that they are to be construed symbolically and not temporally at all, and *preterists,* who opine that they refer to the early days of the Church. The last point of view is of course mainly espoused by secular exegetes, although some theologians have tried to construe the Apocalypse as referring to the fall of Jerusalem in 70 A.D. See [Froo46], [Eric77], and [Kirs11].

[2017] See [MCS98] vol. I p. 127 et seqq. (in particular the essay [Vand98]), [McGi94b] p. 3 et seqq., and [Gedd11].

[2018] As pointed out by [Lern98], millenarianism played only a very minor rôle in early Christianity and was by and large put to rest in the Latin West by St. Augustine's amillenarianism, which was also later accepted by the leading Reformers. In particular, the interpretation of the millennium as a period of earthly delights, advocated, for example, by the Gnostic Cerinthus, has been almost universally abhorred by orthodox Christian theologians of all ages.

question is more difficult to answer. Whereas it certainly is true that Islam means "submission" (viz. to the will of God), that this God-serving attitude of mind is profoundly inculcated by the ostentatious ritual expressions of piety the Moslem is obliged to carry out every day, and that many Moslems certainly have sincerely believed themselves to pursue the will of Allah rather than their own or their nation's interests by their participation in the policy of bellicose expansionism, it is hard, at least for a non-Muslim observer, not to discern a streak of practical, not to say cynical, cunning in the laws and regulations Mohammed imposed upon his followers. In particular, the form of immanentist Messianism so prominent in Islam, similar to and obviously influenced by the political-nationalist Messianism of late Judaism, but further amplified through the notion of *jihad,* seems to make Islam, at least in its original appearance, look suspiciously like a grand military project, or as Bernard Lewis put it "in its early stages, not so much a religion as the distinguishing mark of the conquistador aristocracy and the official credo of the state that represented them".[2019] Still, if Islam is a cry to arms, it is a cry fuelled by the appeal to the divine will – certainly, the strongest of all arguments – rather than to the individual's desire for individual or collective power and material gains. And even though the fabulous military expansion of the Arabs during the early Middle Ages doubtless was greatly helped by their religious ardour, this spell of military expansion is not unique in history – after all, Assurbanipal, Nebuchadnezzar, Alexander, Caesar, or Genghis Khan were certainly not Moslems, Jews, or Christians!

Fourthly, although natural theology may have been somewhat conducive to the creation of a positive climate for the study of the great Book of Nature as an expression of the wisdom of God, it is hardly the cradle of science, but rather a *pretext* for the pursuit of scientific studies in the face of the widespread Christian doubts about the ethicality of such *curiositas* – and in particular so when its foremost object turned out to be the "secrets" of the occult arts.[2020] Nor is natural theology a child of the Christian religion in the first place, which, being based in Faith in Christ, the life of the Spirit, and the experience of the Holy Ghost, has little need for intellectualist proofs of God's existence, but was appropriated by the Scholastics from the Greek philosophers, in particular the Stoics, in their attempts to undergird and defend the Christian religion with rational arguments against the various heterodox or anti-Christian strains of thought that began to make their presence increasingly felt during the High Middle Ages. Additionally, the most celebrated of the medieval proto-scientists were all Ockhamists, who generally took little interest in natural theology and frequently questioned or denied the validity of its proofs for the existence of God. Nor did the Ockhamists celebrate the rationality of God, but rather they espoused a "voluntarist" view of Him – reminiscent of the view of the orthodox Islamic Asharites – as totally free to do whatever He likes and inscrutable in His ways, which are beyond the ken of frail human reason. This "irrationalism" may indeed have encouraged a certain empiricism, in opposition to the Scholastic Aristotelians' rationalist sanguinity as to the capability of the human mind to grasp the principles of being by ratiocination, but it hardly provided any incentive for the scientific exploration of the world. On the contrary, this emphasis on the freedom of God to do as He likes will be apt fatally to undermine the scientific project, as it indeed did in the Moslem world, because a free, personal God may at any time change His mind and will not submit to the yoke of a set of natural laws that some proud scientists wish to put on him. To medieval man, the wonders worked by the saints as well as many other miraculous events provided overwhelming empirical verification that this is actually the case, as, besides, the paranormal phenomena have done to some latter-day investigators of the miraculous.

Nor do I think that the "realistic" conception of the world, which some Christian apologists claim to be specifically Biblical and Christian – starkly opposing it to, for example, the Indian pantheist, acosmist notion of the veil of Maya – and some historians of science, following suit, have identified as a distinctly Christian element constitutive of science and strongly conducive to its birth in the Christian West, is necessarily the best way to describe the creationist worldview of the Abrahamitic religions.[2021] For one thing, the Christian – and, indeed, the universally religious – belief in miracles, that a man of the right faith may miraculously cure the sick, raise the dead, levitate to the tops of the trees like St. Joseph of Cupertino or even further to the third heaven like St. Paul, turn up at two locations concurrently like Padre Pio, see the heaven open like St. Peter, or, according to the testimony of our Lord, even move the mountains, does not seem to imply that Christians are inclined to take everyday reality and the usual course of nature at face value, as something absolutely given and supremely "real". Nor did Christians generally do so before the onset of modernity, but were rather wont

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[2019] [Lewi40] p. 91 et seq.

[2020] See [Eamo94] p. 58 et seqq. and [Pete82].

[2021] See, for example, [Jaki90] for an example of this kind of argumentation.

to interpret nature symbolically and mystically, as replete with moral lessons, signs, mirabilia, and "vestigia Dei". Only as Christianity had started losing its grip over the souls, did Christians begin to look at the world in the – purportedly Christian, but rather inherently secularist – realistic way, as a clockwork ruled by impersonal "laws of nature" instituted by an aloof deist Godhead in the beginning. Indeed, the notion of a miracle, when taken seriously, will be apt to undermine, nay will be entirely at loggerheads with the modern 'scientific' faith in the laws of nature and in the absolute reality and primacy of the material aspect of existence, as also reflected in the widespread and vehement antagonism to research into the paranormal amongst the devotees of scientific materialism.

By the same token, the contention that a Jewish-Christian positive valuation of nature, in contradistinction to the Gnostic-Cathar anticosmism, provided a hothouse for innerworldly technoscientific activity, albeit perhaps not entirely destitute of truth, also seems to miss the mark – in fact, Gnostic anticosmism is rather to be understood as the absurd escalation of the Christian spirit of sober asceticism and aloofness towards the world. According to Christian belief, the current world is under the curse pronounced by God after the Fall of Man and soon to be replaced by another, rectified creation, to which good Christians should attach their hopes rather than to the current, imperfect order, dominated by the Prince of this World. Additionally, the bright and breezy view of matter purportedly reflected in the Christian doctrines of Incarnation and Resurrection and occasionally alleged to have encouraged thisworldly technoscientific activity stands out in strong relief against the extraordinary suffering and anguish involved in the Incarnation, inflicted upon the guiltless Christ, that is upon God Himself, at His salvific death on the Cross as well as against the – nowadays often quickly glossed over – Christian doctrine of the transformation of "the natural body"– characteristically referred to as "our vile body" by the Apostle[2022] – at the Resurrection into an entirely different and far superior, incorruptible "spiritual body" similar to the *corpus gloriosum* of the Resurrected Christ, as "flesh and blood cannot inherit the kingdom of God".[2023] Although Christianity certainly does not espouse Gnostic anticosmism or a Platonic, abstract conception of the soul, the talk of the Jewish-Christian positive valuation of the created world must be properly qualified and, thus qualified, this positive valuation will, in our contention, also lose its explanatory power as to the birth of science.

It has also been suggested, both by White and others[2024], that the Christian imperative of love, compassion, and concern for one's neighbour was instrumental in shaping Western technopolitical activism. Although a velleity to save mankind from material need and political oppression will indeed have spurred some individuals to scientific, technological, and political activity and perhaps in particular so within certain fields, such as the care for the sick, the crippled, and the poor, such incentives are hardly exclusively or particularly Christian, nor can they account for the larger portion of activity within these domains. Additionally, such idealism in no way liberates the pious researcher from the Christian duty to think critically about the probably highly ambiguous or, ever and anon, obviously deleterious long-term, and at times not so long-term, effects of his work. The restrictive force of this duty was in fact widely felt and strongly held back inventiveness until the onset of the "modern constitution" and the "Cartesian divide".[2025] And only by an extraordinary amount of naïveté, credulity, and straining of the facts will it be possible to construe the development of weapons, aeroplanes, automobiles, computers, chemical substances, or power plants, research in ballistics, nanotechnology, genetic engineering, virtual reality, algorithms, programming languages, or nuclear physics, or the professional pursuit of a political career as the outcome of Christian charity – save for, perhaps, in certain exceptional individual cases. If such motivations indeed will be present in some individuals, they are, however, more likely to serve as the kind of hollow pretext and self-delusion, against which Christ repeatedly warned His disciples, notably by declaring His kingdom not to be of this world. In fact, we started this historical exposé by a discussion of the three temptations of Christ, which we, following Eitrem, construed as primarily concerned with magic. Indeed Christ's steadfastness against these temptations has always served as a paradigmatic warning to earnest Christians not to be deceived by the devil's delusive wiles, whether he couches his temptations as traditional occultist or as modern techutopian magic. As a matter of fact, only through the effects of general secularisation and de-Christianisation, that is to say the replacement of

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[2022] *Ep. Phil 3:32*

[2023] See *1 Ep. Cor. 15:35-58.*

[2024] See, fore example, [Maur83].

[2025] See below p. 521.

the Kingdom of God with the Kingdom of Man, have these kinds of activities become preponderant and widely celebrated in the Western world.

Thus, on closer analysis, the Biblical or Christian themes, which White and others have held to be at the root of our ecological crisis, do not appear to be Biblical or Christian at all, insofar as they have very little to do with the real purport of the Biblical passages, from which White derived them, have no or, at best, very faint support in the main Christian theological traditions, and are glaringly at odds with fundamental Christian sentiments and doctrines. In actuality, these themes are distortions or, in Voegelin's terminology, immanentisations of Biblical – and, occasionally, extra-Biblical – motifs, at times reflecting a will to reshape a Christian message into something that it is not in order to sanction and support certain cherished opinions, agendas, and pursuits, at times deriving from a more or less unconscious transposition of structures of thought from a religious to a secular context.

But what are the roots of technoscience and the Faustian turn in the West then, if they are not Christian? It has been aptly observed, "The origins of Western science and technology are multiple, complex, and obscure. It is a false simplification to identify and make prominent one particular religious strand when so many secular factors were also at work, like geography, climate, population growth, urbanism, trade, democracy, and humanistic philosophy."[2026] True as this will be, the secular factors are still not autonomous or freewheeling, but are responded to, belaboured, and, in some cases, given shape to through mental processes, which remain in the domain of the spiritual even when unfolding in the minds of arrant atheists and materialists. And even though a plethora of factors was instrumental in giving birth to modern technoscience, it may, I believe, be possible to identify the catalyst that set the process going.

As Voegelin clearly saw, the immanentisation of Christian motifs, which have, mistakenly forsooth, led many erudite men to search the roots of modernity in orthodox Christianity itself, is correlated to the strong gnostic-occult undertow of Western thought. Starting out at about the same time as Pierre Duhem and Max Weber made their pioneering studies and working sedulously for a large number of years – extending well into Lynn White's academic career – on his magnum opus *A History of Magic and Experimental Science*[2027], Lynn Thorndike made a very different, but no less ground-breaking revisionist attempt to understand the roots of modern science and technology than did these luminaries, deriving them from the occult arts. As we, taking advantage of Thorndike's and a large number of others scholars' work[2028], have attempted to show above, such keystones of modern science as the experimental method and the concept of natural law, and, most importantly, the entire ethos of manipulative, power-oriented voluntarism, curiosity about secrets and hidden things, and boundless intellectual pride, on which Western science and technology so firmly rest, being fundamentally at odds with the inmost soul of Christianity, emerged from non-Christian, or shall we rather say anti-Christian, sources and, in particular, from the practices and attitudes cultivated in magic and the other occult arts, which constitute the backbone of the gnostic or gnostically tinged – Neoplatonic, Hermetic, Cabalistic, etc. – complex of ideas that from the 12th century onwards so fatefully has spellbound Western intellectuals and still so does, although largely unrecognised and under cover. This gnostic-occult tradition can be traced back to late Antiquity, and we argued above that it actually emerged as a reaction against Christianity, integrating flotsam and jetsam from various pre-Christian traditions, of which orthodox Christianity generally disapproved or was highly suspicious. Its perennial allure is reflected by its recurrent recrudescence in the history of our culture, albeit in perpetually new garbs, alliances, meshworks, and mixtures, providing the common soul of, for example, Catharism, Amalricianism, the Brethren of the Free Spirit, the learned pursuits of the occult arts, Renaissance Hermeticism and Platonism, Christian Cabala, Rosicrucianism, early modern science, Freemasonry, Illuminism, the Enlightenment, Mesmerism, Romantic and fin-de-siècle occultism, spiritism, theosophy, psychoanalysis, and the occult wave of the 1970s, only to mention a few of its more spectacular appearances on the Western stage. Later, I will discuss how the computer embodies various dreams and notions of this tradition

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2026 [Derr75] p. 43

2027 [Thor23]

2028 See e.g. [Thor23], [Eamo83], [Eamo94], [NG01], [Webs82], [Rude88], [Hans78], [Hans86], [Newm89], [Cope90], [BS75], [MST78], [WM77], [Vick84], [MD88a], [McKn89], [McKn91], [McKn92], [Duse99], [DW98], [Wagm42], [Olso82] vol. 1 p. 230 et seqq., [Crom94] vol. I p. 333 et seqq., and [Gibb01] p. 38 et seqq. Cf. also [Whit90a] p. 10 et seqq.

But why did the Faustian mutation happen in the Latin West and not amongst the Eastern Orthodox, the Jews, the Muslims, or elsewhere? As a matter of fact, it did not happen in the West in the first place at all, but only arrived here from the East. The purportedly "Western" alloy of a quasi-religious belief in knowledge/science, immanentised activist chiliasm, and revolutionary utopianism was, as I have tried to show at some length above, actually born, albeit perhaps still in a somewhat inchoate form – but not more inchoate than the brand that was to appear in the West during the 12th century –, in the Islamic world and, in particular, amongst the Ismaili Gnostics, already in the 10th century, if not earlier, although, because of the political infarct of the Fatimid caliphate and the other Ismaili states, the havoc wreaked upon the Islamic culture through the Mongol invasion, and the violent reaction to the Ismaili and kindred rationalist ideas in the Moslem world at large, it never had the opportunity to unfold in the East in the way it would do in the West. Of the medieval technological inventions and discoveries, which largely emerged from or were closely related to the pursuit of the secret arts and the needs and interests this pursuit fostered, a very large portion was – as reflected in the plethora of Arabic loan words still in use[2029] – either made in the Moslem world or was, when made in the West, inspired and made possible by the preparatory work laid down in the writings of the Moslem philosophers, occultists, and scientists. The astrologers' need for exact observation of the positions of the heavenly bodies, complex calculations, and exact time-keeping provides the backdrop for the development of various new types of astronomical equipment (such as the astrolabe), the compass, various mathematical novelties and utensils, and the mechanical clock – so often proclaimed to be the most consequential of the technical achievements of the Latin West.[2030] Also the alchemists developed a wide range of equipment, which they then used to discover various new chemical and metallurgical processes and substances. The interest in optical phenomena and magnets, which led to the invention of the lenses, the spectacles, and the compass, is clearly related to the theoretical discussion about the operation of magic and astrology.[2031] Likewise, the mechanical arts – as technology was generally referred to at this time[2032] – were in the Middle Ages, at least in the popular mind, closely associated with magic,[2033] and their increasing status seems largely to be the consequence of Islamic influence.[2034] Exactly how, where, when, and why this Faustian mutation happened admittedly remains obscure, although we may discern some of the components that helped to bring it about:

- *the Hermetic sciences* (from pagan Hermeticism – notably, the Sabians –, Gnosticism, and Manichaeism), supplying both the unrestrained gnostic-scientific curiosity about the secrets and hidden laws of the cosmos – i.e. about the *batin* aspect of nature – and the ruthless magic-technological will-power, the urge to bend the world to one's own advantage without much concern about the consequences
- *numerological and alphabetical mysticism* (from Pythagorean-Platonic philosophy, Hermeticism, certain strains of Gnosticism, and, perhaps, Jewish Kabbalah), providing a theoretical-speculative mindset devoted to the quest for mathematical, logical, and other patterns behind the phenomena, as instigated by the 'scientific' curiosity about the secrets of nature
- *the staged theory of history* (from Islam, astrological-numerological speculation, and, indirectly perhaps, Zoroastrianism, certain Jewish factions such as the Qumran sect, and the Church

[2029] [Sing72] p. 117 et seq. lists some such terms. Cf. also [Watt72] p. 85 et seqq.

[2030] Whereas Lynn White generally argued that during the Middle Ages there was very little interaction between (conservative-theoretical) science and philosophy on the one hand and (progressive-practical) technology and the crafts on the other, in [Whit78] p. 297 et seqq. he discusses some medical astrologers who were keenly engaged in the development of the instruments they needed.

[2031] See [Hans78], [Hans86], and [Lind81].

[2032] According to [Whit90a] p. 148, the term "technology" only appeared in the 17th century. The Carolingian Neoplatonist John Scotus Eriugena, being active in the 9th century, appears to be the first to use the term *artes mechanicae* as a general designation for the crafts and technology (id. op. p. 70).

[2033] See [Hans78], [Hans86], [Eamo83], and [Whit90a] p. 67 footnote 47.

[2034] See [Whit90a] p. 130 et seq., p. 148 et passim. The first to express a higher appreciation of the *artes mechanicae,* which had been generally looked down on as banausic in Antiquity, will be John Scotus Eriugena (see [Whit90a] p. 70 et seqq. and [Nobl99] p. 14 et seqq.). His judgement seems to be grounded in a higher valuation of manual labour, perhaps a consequence of the way of life and the practical interests cultivated in the monasteries (see [Ovit87] p. 88 et seqq.). In the 12th century, Hugh of St. Victor followed suit and later Roger Bacon and Dominicus Gundassilinus, these latter both being strongly influenced by Islamic ideas. Cf. also [Ovit87] p. 107 et seqq. and [Alla82].

Fathers) providing a proto-progressivist conception of history as an innerworldly development in time towards a goal

- *the idea of self-salvation* (from Gnosticism) providing the motivation for man's restless activity in order to achieve the perfection needed for salvation
- *immanentist activist utopianism* (from Islam with its concept of *jihad* and proclivity for temporalised apocalypticism, and, indirectly, from Jewish political Messianism, enthusiast or millenarian Gnostic and Judaizing Christian sects, and, perhaps, Greek political philosophy) supplying the hope for a state of perfection in this world through man's control of nature by technoscience and of society by utopian politics as well as the impetus to implement this state here and now
- *atheism, materialism, rationalism, thnetopsychism, libertinism,* and *politico-religious cynicism* (from antinomian Gnosticism, radical-anarchistic Manichaean dualism, ghulat Shiism, and Greek philosophy in the Sophistic-rationalistic tradition) – be these features really ever the innermost core of the Ismaili secret doctrine, only a mutation or tendency in some more or less ephemeral varieties of it, or but a spectre in the minds of the enemies of the sect – fomenting, or capable of fomenting, the audacity and callosity needed for the project of revolutionary transformation of the world, be it of a political, technological, scientific, philosophical, or some other order

The repeatedly frustrated Islamic and, in particular, Ismaili hopes for the *qiyama,* the Resurrection and great transfiguration of the world, paved the way for the spiritual and allegoric re-interpretation of this event (and then of Heaven, Hell, and other religious notions) as a kind of innerworldly change – an "evolutionary leap" in the lingo of the New Agers and neo-Darwinists –, which together with the staged, proto-progressivist Ismaili hierohistory provides a link between orthodox Jewish-Christian-Moslem eschatology and the immanentised variety hereof that is the starting-point of Faustian modernity. The Ismaili revolutionary-utopian projects and preliminaries to the large-scale utilisation of knowledge for practical, innerworldly purposes also foreshadow what was to come in the West. As I argued above, the millennialism and staged theory of history introduced into the Latin West by Joachim of Fiore and the Amalricians – blamed by Voegelin, Löwith, and others as the origin of the thought structures that made possible the various derailments of modernity – were probably adapted from Ismaili or cognate Islamic sources, although exactly how this happened remains to be investigated.

Through the influx of Gnostic-occult ideas and other novelties from the Islamic and, to a much lesser extent, Byzantine worlds during and after the 12th century Renaissance, the Latin West, as outlined above, went through its own Gnostic-Faustian mutation, which provides the backdrop of the mounting readiness uncritically to accept scientific curiosity and technical innovations. Also the large and mighty institutions, which played an increasingly important rôle in medieval society – the growing powers of the state, the large-scale monasteries and feudal fiefdoms, the wealthy and powerful military monastic orders, such as the Templars, acting as international bankers ready to finance grand projects they approved of – made it expedient and alluring to embark on large construction endeavours and adopt new labour-saving inventions – as did the rising cost of manual labour, which due to the reliance on slavery had been comparatively cheap in Antiquity. Additionally, technological change has always tended to be midwived by great dangers, in particular of a military character, as might have been the case, for example, in the adoption of the stirrup in the early Middle Ages. The Islamic threat, very much alive in the minds of men throughout the Middle Ages, may thus also have made for the easier acceptance of innovations, at least if these were strategically important. Still the religious scruples about the occult sciences, the mechanic arts, curiosity, etc. remained strong and needed to be abolished before the floodgates of modernity could be opened.

The reason why there was no Faustian mutation in the Byzantine Empire is hardly to be sought in the, in our view at least, rather chimerical difference between the intellectualism of the Byzantines and the voluntarism of the Latins, or for that part, in any other of the mostly rather subtle theological issues, over which Western and Eastern theologians disagreed. The Byzantines simply took little notice of Arabic literature and culture, as Aristotle's and the other ancient authorities' writings, which – together with a large corpus of Arabic pseudepigrapha, commentaries, and other literature – were so avidly translated from the Arabic to Latin in Toledo, Sicily, and elsewhere in the West, were still extant and readily available in the original Greek,

still generally understood by educated men. Thus, the influence of Arabic-Gnostic science, philosophy, and occultism, which so fatefully influenced the Western world, was not strongly felt in Byzantium.[2035] In the end, the Byzantine Empire would also have to pay for its uncompromising conservatism by its own downfall, although this may indeed have been a price worth paying for being true to fundamental Christian ideals.

Although modern technoscience did not emerge from the Christian ethos, with which it was and arguably forever remains fundamentally at odds, it was nonetheless in a sense born out of Christianity, albeit only as part of the Gnostic reaction against it, as an anti-Christian rebellion against the gospel of love and redemption, of the crucified Christ, who will always, of course, remain "unto the Jews a stumblingblock, and unto the Greeks a foolishness".[2036] What was needed to deliver the gnostic-occult mother of the scientific-technological child in a still Christian world was the gradual undermining of the Christian faith that stood in the way of the realisation of the Gnostic dreams about an innerworldly pleroma through the reconstruction of this worthless scrap world, which, according to some of the more popular varieties of the Gnostic mythology, had emerged out of chance, implacable mathematical necessity, the spite of an evil Demiurge, or by some kind of disastrous mistake perpetrated by the strange powers of the celestial or supercelestial realms. We must not here let ourselves be deceived by the pious-sounding language and arguments – medicine needs astrology and the elixirs of alchemy to care for the sick, Christians need better weapons to fight against Antichrist, man should take advantage of the dominion over the creation God has given to him to regain the prelapsarian perfections, etc. – by which the men touched by these dreams – Roger Bacon, Francis Bacon, René Descartes, Isaac Newton, Adam Weishaupt, Henri Saint-Simon, and innumerable others – typically framed their pleas, as the sorcerers who authored the ancient Hermetica or the medieval grimoires had done before them. Nor do we necessarily need to question their sincerity – although at times we indeed must –, as this was simply the only language possible to use in an altogether Christian world, before the Enlightenment fundamentally reversed the rules of public discourse. We do not need here to repeat our discussion of the different steps in the progressive derailment of Western thought – how Roger Bacon introduced technical utopianism, Ockham the spurious principle of thought-economy, Francis Bacon the agenda of militant utilitarian scientific progress[2037], Descartes the modern constitution, the *philosophes* of the 'Enlightenment' the new religion of man and progress, Hume the prohibition of miracles, etc. But it will certainly be about time we contemplated the concept of immanentisation a little closer in order to gain an understanding of its mechanisms and consequences.

[2035] [Shbo91] p. 148 laconically remarks, "few Arabic books (one on dreams) were rendered into Greek", although according to [PK91] some important Arab astrological works were indeed also translated into Greek. The Byzantines were of course not totally adverse to the occult arts – after all Byzantine Egypt had been the hotbed of Hermeticism together with the occult sciences in all forms. However, the loss of Egypt to the Arabs sapped the interest in these topics within the Byzantine Empire – at least the interest there never took on the same proportions as in the West. See [Magu95], [PC91], [PK91], and [KT91].

[2036] *1 Ep. Cor. 1:23*

[2037] See [Fort95] p. 215 et seqq.

Jag verkar bäst inkognito.

The Devil[2038]

Einen Thron will ich mir auferbauen,
kalt und riesig soll sein Gipfel sein,
Bollwerk sei ihm übermenschlich Grauen,
und sein Marschall sei die düst're Pein.

Wer hinaufschaut mit gesundem Auge,
kehre todtenbleich und stumm zurück,
angepackt vom blinden Todteshauche,
grabe selbst die Grube sich sein Glück.

Karl Marx (from the poem "Des Verzweiflendem Gebet")[2039]

Before Christ's second coming the Church must pass through a final trial that will shake the faith of many believers. The persecution that accompanies her pilgrimage on earth will unveil the "mystery of iniquity" in the form of a religious deception offering men an apparent solution to their problems at the price of apostasy from the truth. The supreme religious deception is that of the Antichrist, a pseudo-messianism by which man glorifies himself in place of God and of his Messiah come in the flesh. The Antichrist's deception already begins to take shape in the world every time the claim is made to realize within history that messianic hope which can only be realized beyond history through the eschatological judgment. The Church has rejected even modified forms of this falsification of the kingdom to come under the name of millenarianism, especially the "intrinsically perverse" political form of a secular messianism.

Catechism of the Catholic Church 675-676[2040]

… addiction now substitutes for tradition. With the decline of historical narrative and the continuing destruction of older places and communities by the forces of late capitalism, addiction, at least, is predictable: what is consumed is the same each time, the parameters become known, and surprise is minimized.

Ken Hillis[2041]

In this study, it will only be possible to touch lightly on the much-debated and intricate topic of the actual historical unfolding of the process of immanentisation, whereby ideas and notions appertaining to the transcendental-eschatological realm, and in particular to theology and religious philosophy, are transposed into a secular or immanent context and given a new, predominantly or entirely innerworldly import, essentially different from their original acceptation.[2042] The significance accorded by Voegelin to Joachim of Fiore's apocalyptic-eschatological speculations as a crucial, first step in the immanentisation process has already been

[2038] In 1908, the Swedish newspaper *Dagens Nyheter* declared the devil abolished. The editors hereupon received an anonymous telegram of the above wording, written by the author Hjalmar Söderberg. See [AW01] p. 124.

[2039] [Marx75] p. 641

[2040] [Cate92]

[2041] [Hill99] p. 29

[2042] For one thing, I will not here compare Voegelin's conception of "immanentisation" with the various theories of "secularisation" and "disenchantment" or with other scholars' attempts to track down the history of these processes, as done in, for example, [Buij01]. See [Webe34], [Schm34], [Blum99b], [Dobb84], [Chad90], [Gauc97], [McLe00], and [Berg90b] p. 105 et seqq. For a brief, but illuminating "excursus" on the secularisation debate – including ample references to the literature – see also [Gay98] p. 18 et seqq.

hinted at.[2043] Besides the basic idea of the *three ages* of the Father, the Son, and the Spirit, i.e. the eras of Jewish religion, Christianity, and the imminent post-Christian outpouring of the Spirit, the Joachitic scheme also comprised the ideas of the *leader* (Abraham, Christ, and the *dux e Babylon,* corresponding to the three Joachitic ages), who inaugurates each age, the *prophet* of the coming age (St. John the Baptist for the age of the Son, Joachim himself for the age of the Spirit), who in the later variations on Joachim's scheme sometimes merged with the leader, and the *brotherhood* of autonomous spirituals, who, liberated from all current institutional authority, will make up the ascetic élite of the new age.[2044]

In Voegelin's view, this general Joachimitic pattern recurs in a plethora of modern gnostic systems, where, for instance, the rôle of the *prophet* will be played by the intellectual originator of the new system (Postel, Bacon, Hegel, Marx, Freud, etc.), whereas the rôle of the élite *brotherhood* is played by the activist devotees of the gnostic system. Similarly, Joachim's *leader,* the "spiritual superman", as it were, was to be followed by Weishaupt's illuminist, Condorcet's progressivist, Comte's positivist, Marx' communist, and Nietzsche's Dionysian superman, and then by Lenin, Stalin, Hitler and their likes. The notion of a progression through *three ages,* of which the last will be the age of perfection, liberation, freedom, happiness, etc. now about to erupt, will also recur ever and again amongst the historiosophers. Influential instances of this trimorphic obsession are Petrarch's and the Renaissance humanists' classical, dark, and modern ages[2045], Vico's three ages of

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[2043] See footnote 1621 on p. 335, [Voeg97] p. 63 et seqq., and [Voeg87] p. 110 et seqq. Cf. also [Löwi53] p. 136 et seqq. On Joachim and his aftermath, see [Reev77], [Reev69], [Reev99], [RG87], [Anit31], [Huck38], [Grun66], [Grun77], [WZ83], [West75], [McGi85], [McGi94b], [Mort58], [Leff67] p. 51 et seqq., and [Cohn70a] p. 108 et seqq. The somewhat shadowy pantheist sect of the Amalricians, which appeared in the early 13th century and often has been assumed to be the origin of the later eruption of "the heresy of the Free Spirit" (see e.g. [Cohn70a] p. 152 et seqq. and [Dick89] p. 359, although this is doubted in [Lern] p. 13, the standard work on the latter heresy, as well as in [Leff67] p. 309), also supported the notion of the three ages of the Father, the Son, and the Holy Ghost. The striking parallels between the Amalricians' and Fiore's ideas on the three ages have puzzled many scholars, but it is moot whether Amalric borrowed the notion from Joachim or he and Joachim relied on a common source (see [Dick87], [Reev69] p. 473, [Anit31] p. 275 et seqq., and [BR54] p. 783). We argued above that Ismaili Messianism is a likely candidate for such a common origin.

[2044] Although not without forebears amongst sectarians and heretics of early Christianity, such as the Montanists (see section XII of [McGi94b] p. 22), modalists, and Sabellians (see [Brow84] p. 99 et seqq.), Joachim's tripartite historical construction is very different from the at his time widely accepted 'amillennialist' scheme of history codified by St. Augustine, to whom the two great events in the history of mankind were Creation and Calvary and the age of grace commencing at Calvary, likened by him to the old age of man (*saeculum senescens),* was but a protracted interval, the sole purpose of which will be the propagation of the Christian gospel to all peoples and tribes until the end of time, when the Resurrection of the dead, the Last Judgement, and the final separation of the *civitas Dei* and *civitas diaboli* will supervene. On the history of Christian apocalypticism, see [Froo46], for whom, however, Joachim is a great hero. Cf. also [Webe99], [Thom96], [Löwi53] p. 148 et seqq., and section XII of [McGi94b], who also discusses various other Christian construals of history, such as the Pauline four-stage theory *(ante legem, sub lege, sub gratia, in gloria),* and the seven 1000-year eras of the "World-Week". On St. Thomas' and various other theologians' criticisms of Joachim's triadic scheme of history as endangering the centrality of Christ, see section X of [McGi94b]. Joachim also held other theologically suspicious views: Notably, his doctrine of the Holy Trinity, held to border on tritheism, was condemned at the Fourth Lateran Council in 1215.

The idea of the millennium goes back to *Apoc. 20,* but, according to Papias' testimony, Christ himself taught it (see [McGi94b] section I p. 27), and it is also present in the *Second (Slavonic) Book of Enoch* – held to be contemporary with the life of Christ by some scholars (so [Char70] p. 315), although this dating is extremely uncertain (see [Char83] vol. I p. 94 et seq.) –, where the millennium is made the last period of the World Week. [Cohn70a] pillories millenarianism as a major source of antinomian revolutionary anarchism in the history of the West, whereas [Maur83] makes it the source of the modern Western scientific-technological onslaught. An extensive bibliography of apocalypticism is provided in [McIv99], an "encyclopedia", comprising a number of interesting articles by leading scholars of the field, in [MCS98], and selections of important apocalyptic texts in [McGi80] and [McGi98]. [Bull95] and [McGi94b] provide collections of papers by leading scholars in the field. See also [Heid93] and http://www.mille.org, the web site of the *Center for Millenial Studies.* It should be noted that immanentisation will not be a process unique to the Christian West, but is also occasionally encountered elsewhere, notably in 5th century Greece, where, for instance, Thucydides' model of apparently wholly immanent historical causation and explanation may, perhaps, be construed as an immanentisation of Herodotus' and Sophocles' theological model of historical causation, based on the concepts of *hubris* and *phthonos theon.*

[2045] Albeit heavily influenced by Joachimism (and, as suggested by [Bouw57] p. 46 et seqq. and p. 143 et seq., possibly also directly by Ismailism in its Druze embodiment), Guillaume Postel, the Renaissance prophet extraordinary of the *restitutio omnium* and the imminent golden age of reason and *concordia mundi,* preferred – on mystical and other grounds – quadruplets to triads, thus relying in his millenarian speculations on the traditional scheme of the four epochs *ante legem, sub lege, sub gratia,* and *in gloria*, which he combined with the notion of the world week and Albumasar's astrological theory of celestial conjunctions as indicators of new epochs. See [Bouw57] p. 57, p. 107, p. 160 et seqq., p. 251 et seqq., and, in particular, p. 281 et seqq. Cf. also [Kunt81] p. 173 et seqq. and [Åker98] p. 173 et seqq. In a work published in 1531, Pierre Turel of Dijon also toyed with the idea of four epochs, of which he, on astrological grounds, made the last begin in 1789 (see [Bouw57] footnote 83 on p. 283 et seq.)! The intense interest in astrology/astronomy and conjunctions in these times was closely connected with the rampant millenarian speculation of the Reformation. In particular, the supernova of 1572 created a major stir, bringing forth a flood of writings, by Postel, John Dee, Tycho Brahe, and many others (see [Åker98] p. 202 et seqq.). As for the "Rosicrucian Enlightenment" and Joachimism, [RG87] p. 25 et seq. readily writes off any significant Joachimist influence on the Rosicrucians, but arguably is able to do so only by adopting a very narrow understanding of what constitutes an "influence".

the gods, the heroes, and men, Lessing's ages of the law, the gospel, and reason[2046], Saint-Simon's eras of universals/generalisation, individualism/particularisation, and positivism/brotherly love[2047] Comte's theological, philosophical and positivist eras, Schelling's (and then Baur's) Petrine, Pauline, and Johannine eras construed as the three ages of the law, prophecy, and, as a climax, freedom[2048], Hegel's ubiquitous use of the three-fold scheme of thesis, antithesis, and synthesis, as in his strikingly Joachitic macrohistorical construct of the *thesis* of the Age of the Father, during which, as exemplified by the Jewish dispensation, God and man were absolutely separated, the *antithesis* of the Age of the Son, when God and Man become united in Christ, and the synthesis of the Age of the Spirit *(Geist),* when, starting through the new *Innerlichkeit* of Meister Eckhart and the Reformers, God pantheistically becomes "all in all", Marx' sequence of societies culminating in classless communism[2049], the millenarian empire of the "chosen class", to say nothing of the National Socialist *Third Reich,* based on the notion of three eras of German history, the paradise of the "chosen race" under its quasi-Messianic *Führer.*[2050]

In essence, the Joachimists, by immanentising, or, as it were, drawing down to the present earth, the immanent realm, the Christian eschatological hopes concerning both the after-life and the new earth and new heaven to be created *after* the end of this world, laid the basis for the foundational modern belief in an innerworldly fulfilment, towards which history by some inner necessity evolves. Still, to Joachim this fulfilment would come through a transcendental irruption, an outpouring of the Spirit, and a spiritualisation of the Church. Only later would this transcendental element gradually wane and the hope for the new age grow increasingly secular, in what can be understood as a second, more radical phase of the immanentisation process.

Additionally, Voegelin in his analysis of the process of immanentisation makes an interesting distinction between two aspects of the Christian idea of perfection or *sanctificatio* (i.e. the pilgrim's progress towards the goal of the *visio beatifica* as a state of perfection), viz. one *teleological,* indicating the movement towards a transcendent goal, and one *axiological* concerned with the goal of perfection itself.[2051] The result of the immanentisation of the teleological component is, according to Voegelin, *progressivism* (as with Kant or Condorcet), of the axiological element, *utopianism* (e.g. Thomas More), of both, *activist mysticism* (as in Marx or Comte) – the last variant being the most noxious form.[2052]

In two important works largely inspired by Voegelin's ideas, Stephen McKnight set out to track down the critical and paradoxical importance played by the "sacralizing" influence of the ancient wisdom tradition *(prisca theologia)*[2053] for the process of *immanentization* from the Renaissance into our own times.[2054] In this tradition,

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[2046] When he presents his three-stage theory in *Die Erziehung des Menschengeschlechts* and proclaims the Age of Reason as the successor of the Ages of the New and Old Testament, Lessing directly refers to medieval Joachitic speculation – "gewisse Schwärmer des dreizehnten und vierzehnten Jahrhunderts" –, notably also calling the Age of Reason "die Zeit eines neuen ewigen Evangeliums" (§86-87, [Less01] p. 96 et seq.). No longer is the hope for an outpouring of the Holy Ghost, but the third age will be imbued by a mystically conceived, albeit entirely innerworldly rationality, most characteristically implemented "in einer unsichtbaren Kirche", that is to say Freemasonry, as envisioned in his *Ernst und Falk. Gespräche für Freimaurer* (Zweites Gespräch, [Less01] p. 34). Cf. [RG87] p. 59 et seqq.

[2047] See [RG87] p. 49.

[2048] In *Philosophie der Offenbarung,* Schelling takes advantage of Joachim's idea of a concordance between the personages and events of the Old and New Testament and parallels the Old Testament epochs of Moses, Elias, and St. John the Baptist with the New Testament ones of St. Peter (Catholicism), St. Paul (Protestantism), and St. John (the imminent perfect religion of mankind promulgated by Schelling), seeing in both the expression of the same pattern of progression from law over prophecy to freedom. The belief that a new religion (or irreligion), or at least a major revision of Christianity – typically couched as the Age of the Spirit or of St. John –, was imminent and inaugurated by the watershed of the French Revolution was commonplace amongst the Romantics. See [RG87] p. 43 et seqq.

[2049] Another elaborate Joachimitic scheme, featuring the three ages of Adam, Christ, and Spinoza, had been worked out by Moses Hess, Karl Marx' accomplice and devout admirer (see [RG87] p. 64 et seq.).

[2050] For some further examples of the obsession with triads, see [Manu83] p. 169 et seqq.

[2051] See [Voeg87] p. 120 et seq. and [Voeg97] p. 61 et seqq.

[2052] Cf. also [Bill80] on the origins of modern "revolutionary faith".

[2053] See [Walk72].

[2054] [McKn89] and [McKn91]. McKnight's views contrast starkly with those of many neo-Romantics, New Agers, perennialists, process philosophers, etc., such as, for example, Lynn White, Ray Griffin, Philip Sherrard, or Morris Berman, who identify the Western – theological, philosophical, scientific, … – "desacralisation" of nature as the cause of the Enlightenment Entzauberung and the root of the modern woes and call for a re-sacralisation, re-enchantment, or re-paganisation of nature and science.

which became prominent through the influence of the Renaissance Neoplatonic philosophers Marsilio Ficino and Giovanni Pico della Mirandola, man was conceived of as a fabulous magus, "a terrestrial god capable of controlling the natural world and perfecting society"[2055] through natural magic and the other occult sciences, which were later to be replaced by or, perhaps rather, transformed into the modern sciences. It turns out that *sacralisation* and *secularisation,* albeit *prima facie* contradictory, conspire to shape the modern outlook and obstruct the traditional Christian worldview:

> *Secularization results in independence and autonomy from God and the sacred. Sacralization transforms the secular realm to the point where it is indistinguishable from the sacred. Man becomes God, and society becomes an earthly paradise.*[2056]

Furthermore, according to McKnight the modern mindset is characterised by three hallmarks that all can be derived from *prisca theologia,* viz. the beliefs[2057]

1) that an epochal break with the past, which is deprecated as a 'dark age', is about to happen and will usher in a new era of 'rebirth', 'renaissance', 'reformation', 'instauration', 'enlightenment', or 'revolution'
2) that this break will be the result of an epistemological breakthrough, the exact nature of which, however, has been variously construed at different times and by different authors
3) that from this breakthrough and the new knowledge it will engender will follow a recuperation of man's true nature, autonomy, and humanity, putting an end to his present plight of alienation and helplessness.

McKnight also examines at some length the repercussions these ideas have had in the body of opinions of figures such as Bacon, Comte, and Marx.

It may seem paradoxical or even offensive to make the form of intense spirituality that manifests itself in gnosticism, Neoplatonism, Hermeticism, *prisca theologia,* pantheism, enthusiasm, and suchlike and the divinisation of the human soul and/or the outer world asserted in this kind of spirituality the source of materialism, naturalism, atheism, and antinomian nihilism, but the basic pattern recurs so frequently in history that the connection hardly can be dismissed.[2058] In medieval Europe, we can perceive it in a rudimentary form in the

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[2055] See [McKn89] p. 109. Cf. also [Yate82] p. 88 et seq., who points out that Pico's views on the dignity of man were prefigured by John Scotus Eriugena already in the ninth century.

[2056] [McKn89] p. 25.

[2057] Evidently, millenarianism also fostered some of these beliefs. Often millenarian hopes subtly blended with Hermeticism, Neoplatonism, Cabalism, and general mysticism. Another significant influence will be Raymond Lull's works, which are pervaded by hopes for a kind of epistemological breakthrough, a belief that reached a climax in Leibniz' ideas about the *characteristica universalis* (see [Ross00]). Amongst the "themes" [Barz00] regards as constitutive of modernity, the "ideas or purposes that I find recurring throughout the era" (p. xi), *primitivism* is one of the more important – the others themes are *abstraction, analysis, emancipation, reductivism, secularism, self-consciousness, scientism,* and *specialism.*

[2058] It should be emphasised that it is by no means my intention to magisterially condemn spiritual religiosity; nor did Voegelin, who in fact considered himself a mystic, do so. On the contrary, the search for communion with the divine ground will indeed, I contend, be the most proper, noble, natural, and, indeed, rational pursuit man can possibly devote himself to. Yet, it would be naïve to think that mystics are exempt from the temptations, which meet man in all other turns of life, or that derailed or unsound forms of mystic spirituality do not exist. On the contrary, the great mystics have a great deal to tell us about such temptations and the much intensified moral struggles, doubts, and afflictions that they have had to go through. Although explicitly moralising sentiments are not very voguish in our extraordinarily tolerant era, and in particular not amongst academics, who often seem to consider not only themselves, but anything under examination *jenseits Gut und Böse* (except perhaps the very practice of pronouncing moral judgements, which they for some reason or other find apt to moralise about), even the most vociferous adherents of toleration and understanding would presumably, if pressed, admit that, for instance, suicidal or murderous cults, such as Jim Jones' temple sect, the Heaven's Gate UFO cult, or the Japanese nerve gassing sect Aum Shinri-kyo have little to recommend themselves, to say nothing of the perpetrators of the barbarities surveyed in [Davi81] or [NP00] or the many hideous examples of devious mysticism mentioned in [Borc94]. Cf. also [Lher53].

In any case, orthodox Christianity has always tried to sift the wheat from the chaff, orthodoxy operating, as Chesterton so eloquently pointed out in [Ches1908], much like sound common sense, rejecting and suppressing the obviously wrong-headed and fostering the

development from the nascent pantheistic tendencies in still essentially Christian thinkers, such as Eriugena and Joachim of Fiore, to the full-blown antinomian pantheism and materialism of the Amalricians, the zealot party of the Franciscan spirituals, or Fra Dolcino's apostolic brethren[2059], later to reappear in, for example, the aberrant mystics of the heresy of the Free Spirit, heterodox Beghard and Beguine piety, much German mysticism, Molinos' quietism, and Anabaptism, which, together with the Neoplatonically tinged Aristotelianism of the Averroists and Alexandrists, seems to have been one of the earliest hotbeds of atheism in the Christian West.[2060] Even more clearly, this tendency can be discerned in the development of German mysticism, which

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reasonable and noble impulses of man in search for God. Generally speaking, the Roman Catholic and Eastern Orthodox churches have been rather tolerant also towards forms of passionate and ascetic mysticism, which will be apt to give umbrage to Protestant sentiments, but all orthodox Christian churches are adamant not to accept evidently derailed spirituality, which generally tends to reveal its own perversity through eccentric teachings or claims of emancipation from the moral principles taught by the Church. Some evangelical Christian works, such as the erudite and partly quite insightful [AW96], are extremely suspicious and dismissive of mysticism, but although many of the warnings issued doubtless are well-motivated, the overall impression of many books of this mindset is one of excessive alarmism and one-sidedness, which occasionally even runs the risk of ending up in a paradoxically gnostic anti-Gnosticism. The Jewish view of the dangers of mysticism is well summed up in the interesting story discussed in [Idel91] about the four rabbis entering the Kabbalistic orchard, of whom one peeked and was smitten (became mad), one peeked and cut down the shoots (became a heretic), one peeked and died, and only one peeked and descended safely.

Although it might *prima facie* appear that there is little difference between a God, who is omnipresent, omnipotent and omniscient, has created everything, and upholds His creation everywhere and at all times, and a God, who simply *is* everything, it turns out that pantheism, by making everything divine, runs the risk both of 1) fatally undermining all morality, as its fundamental postulate seems to imply that evil is no less divine than good and, thus, as good as good, both being basically the result of God's play *(lila),* and of 2) rendering God superfluous, because if nature is God and God is nature and God thus is deprived of both personality and transcendence, God seems to be but another name of nature. Hence, the former observation may serve us as a provisional explanation of why pantheism historically has tended to breed anomie, nihilism, quietism, or apathy, whereas the latter makes its affinity to naturalism, atheism, and materialism comprehensible. Admittedly, these will rather be tendencies inherent, as it were, in the logic of pantheism than integral elements or necessary corollaries of it, and many, who have expressed religious sentiments of a pantheist bent, would surely balk at one or both of these associations. Notably, the piously inclined pantheist will à la Vedanta opt for the abolition of nature *(acosmism)* rather than the atheistic-materialist abolition of God and the soul.

Furthermore, orthodox Christianity has always been highly suspicious and critical of *enthusiasm,* i.e. the unwarranted belief in being directly led by God or the Holy Ghost through an inner light – referred to as the *extra enthusiasticum* by Lutheran theologians – by virtue of one's own calling or pre-eminent spiritual development, or of being the prophetic mouthpiece of God, or even of being God, when in fact one is only giving free rein to one's own desires and appetites or to other evil influences, thereby committing the mortal sin of (spiritual) pride. At least since the times of the Montanists, Christianity has seen many recurrent fits of enthusiasm, which, regarded by the orthodox as counterfeit forms of genuine prophecy and the true charismata of the Holy Ghost, have tended to inspire all kinds of lunacies and excesses and, in particular, given rise to the claims of infallibility and immunity to sin so typical of enthusiasts (see [Davi43] and [Knox61]; cf. also [Maur83] and [Cong97]). Notably, revolutionary activism can be construed as the upshot of enthusiasm (cf. [Bill80]).

The perceived dangers of enthusiasm also help to explain the difficulties that Christian exegetes have had to reach an agreement on the correct interpretation of the Biblical terms for flesh/body *(basar, soma),* soul *(nefesh, psyche),* and spirit *(ruach, neshamah, pneuma).* Whereas *dichotomists* claim that the soul and spirit are more or less interchangeable terms or, at most, may admit that the spirit constitutes the upper echelon of the soul, *trichotomists* view the soul and the spirit as separate substances and parts of man. In the trichotomists' view, the soul will either comprise man's usual mind and mental activities or be some corporeal substrate of the mind (such as the psychic body mentioned by St. Paul in *1 Ep. Cor. 15:44),* whereas the spirit refers to man's spiritual-mental essence, which the enthusiast will be prone to identify with God. An interesting attempt to resolve the problem is suggested in [Wies57] p. 10, 25, 58 et passim, where the author, while resolutely rejecting trichotomism, makes a distinction between "the soul's two modes of existence" or dual "aspects", the body-soul or corporal soul, which comprises the *anima vegetativa, sensitiva,* and *intellectiva* operative in the normal state of the soul, and the higher spirit-soul or *anima spiritualis,* which manifests itself during certain abnormal states, notably in the mystical life and in various occult phenomena. Cf. also footnote 1473 on p. 296 above.

In the Christian religion, morality is safeguarded by the belief that God created man as an autonomous, morally responsible being with a free will, distinct from God Himself. Therefore, the Christian mystic's *unio mystica* is, at least according to most Christian researchers on mysticism, not to be interpreted as a wholesale submersion of the mystic into God, but as a state, where the independence of both man and God is retained. Thus, this state, albeit implying a close spiritual "union" between the mystic and God, should not be construed pantheistically as a union between the mystic and God's *essence.* For example, in the Eastern Orthodox tradition, where a distinction – not adopted in Roman-Catholic and Protestant theology – is made between God's *essence* and his *energies,* i.e. His external workings or operations, a union with God's *energies,* but not with His *essence,* is deemed possible. See also [Poul1908]. Consequently, there is a substantial difference between Christian mysticism and, for example, the pantheist mysticism of the Upanishads, where the mystic will discover that "tat tvam asi", that his own soul, the *atman,* is in fact God, *the Brahman.* It may be interesting to note that some Moslem philosophers and mystics, such as al-Farabi, Avicenna, and al-Suhrawardi make a similar point as the Christian theologians, preferring *ittisal* (attainment, conjunction without identification) to *ittihad* (unitive fusion); see [Corb93] p. 160.

[2059] Notably, William of Ockham was associated with this party of Franciscan spirituals, although we should be wary of making too much of this connection.

[2060] Cf. [HW92] p. 65 et seqq. The seemingly paradoxical tendency of pantheism to engender atheism can also be seen both in ancient Greece and in ancient India. So, the tendency of hylozoic pantheism amongst the Ionian natural philosophers was soon to be followed by

received a palpable, albeit perhaps largely inadvertent, pantheist impetus from Meister Eckhart, who in turn was much influenced both by the antinomian pantheism of the heresy of the Free Spirit and by the Neoplatonic and monopsychic speculations of Proclus, pseudo-Dionysius, Eriugena, and such Moslem philosophers as Avicenna.

German mysticism was later radicalised and seasoned with elements of Kabbalistic emanationism by the Protestant mystic Jacob Behmen, the *philosophus teutonicus,* who, besides the considerable impact he made on contemporary mysticism and philosophy, also came to wield an enormous influence on the leading Romantic philosophers in Germany[2061] – somewhat oddly, largely mediated through the French mystic St. Martin, *le philosophe inconnu* –, including on Schelling and Hegel, whose pantheism, now almost entirely shorn of its earlier Christian connotations and having taken on an increasingly schematic-intellectual character, was eventually to be transformed into the radical atheism and materialism of Marx, Feuerbach, and the other *Junghegelianer.*[2062] Similarly, Cusanus', Bessarion's, Ficino's, and Pico della Mirandola's mystic-Neoplatonic variety of Christianity – itself a Christian adaptation of Gemisthos Plethon's overtly neo-pagan Platonism –, growing increasingly unorthodox and occultist over time – most clearly in such figures as the notorious occultist Agrippa of Nettesheim –, was transformed into an overtly non-Christian pantheism and mystic materialism by Giordano Bruno, whose writings provided an important starting-point for Spinoza's thinly veiled "pantheist" atheism[2063], which, in turn, together with other Dutch and English free-thought and deism – notably Toland's "pantheism" – provided the cradle for the virulent atheism and materialism of the Enlightenment.[2064]

The inoculation of Neoplatonist emanationism – to say nothing of Gnostic-Hermetic esotericism, occultism, and astro-apocalypticism – on the Abrahamitic religions, as attempted by the Ismailis, such Moslem philosophers and mystics as al-Farabi and Avicenna, the Jewish Kabbalists, and the Christian Platonists and Cabalists, was evidently a risky and delicate matter. In the Moslem world, the process of integrating ancient philosophy with Islam came to a more or less abrupt end in the 12th century – the last Moslem philosopher of note being Averroës – through the scathing criticism of the orthodox theologians, as most famously articulated in al-Ghazzali's *Destructio philosophorum.*[2065] At the same time, this rejected pagan-Islamic legacy was via Spain percolating into the Latin Christian world, where its influence on Christians and Jews alike would prove to be lasting. For all its dubious consequences from an orthodox Christian point of view, it would, however, be rash to denounce the Platonist tradition as just a breeder of heresy, superstition, and unbelief, not only because so many of the greatest – and perfectly orthodox – Christian theologians, including the Cappadocian Fathers, St. Augustine, and St. Bonaventure, were also Platonists[2066] or because, as repeatedly pointed out by many Christian Platonists, Aristotelianism and even the Bible itself – to wit through misrepresentation and misinterpretation – are indeed as great breeders of heresy as Platonism[2067], but also because many

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the nihilism and atheism of the Sophists, whereas the materialism and atheism of the charvakas as well as the 'religious atheism' of the Buddhists and Jainists ensued from the idealistic pantheism of Vedanta. Indeed, it seems that the saying "les extremes se touchent" can be applied also to worldviews, that Poortman's *Zeta* and *Alpha* standpoints are within an inch of each other. As pinpointed by Clouser's aforementioned definition of divinity as "self-existence" (see above p. 307), naturalism, being the belief in the divinity of matter and "the laws of nature", formally comes quite close to pantheism, construed as the belief in the divinity of matter, "the laws of nature", and everything else.

2061 See [Benz83a] and [Wals83].

2062 See [Löwi95] and [Bill80] p. 224 et seqq.

2063 Similarly to Behmen, Spinoza might also have been influenced by Kabbalist emanationism. See [Popk92].

2064 See [Schn47]. Many of the French Enlightenment philosophers, such as Diderot, retained a strong liking for pantheism.

2065 See [Corb93] p. 184 et seqq. points out that philosophy in fact lived on in the theosophical Persian "Oriental philosophy", which still is vigorous in Persia, notably having influenced Ayatollah Khomeini and the traditionalist Shiite movement in this country greatly. See [Rizv01].

2066 See [Iván64].

2067 Cf. [Walk72] p. 110 et seqq. Aristotelianism was, for example, rife amongst the Nestorians, whose leading theologian Theodorus of Mopsuestia was a staunch adherent of the Stagirite. Also some heterodox Platonists were influenced by Aristotle, such as the tritheist John Philoponus. During the Middle Ages and the Renaissance, Averroist and Alexandrist Aristotelianism were notorious as breeders of heterodoxy and disbelief.

elements of the Christian religion become incomprehensible without some kind of Platonism – or at least 'primitive Platonism'[2068] – as a backdrop.[2069]

All these impulses, originally emerging in a Christian context, albeit mostly of dubious orthodoxy or obvious heterodoxy, slowly receded further and further from the Christian framework through the process of immanentisation, until they finally took on their present modernist, ferociously anti-Christian character during the 17th and 18th centuries. Thus, although there lies a Gnostic-Promethean rebellion[2070] against Christianity and the Christian God at the heart of modernity, modernism, for all its odium and gesticulation against the Christian faith, still remains wholly determined by it: Much as the black mass of the Middle Ages was but a parody of the authentic Christian mass, modernism is not able to disengage itself from Christianity, but seems to be made up of all kinds of caricatured, denied, and strangely distorted elements of it.[2071]

It is not difficult to see that in the pursuits and goals of science, and technology as well as in modernism in general immanentised Jewish-Christian and Hermetic-occult debris lurks almost everywhere.[2072] Firstly, the Christian conception of God has largely shaped and informed the modern-scientific conception of "nature" (in terms of space, time, matter, and the "laws" of nature), to which, for instance, the following *attributa divina,*[2073] divine attributes, have now been passed on:

[2068] At the very least, the popularity through the ages of the idea – going back to Philo of Alexandria – that Plato derived his philosophy from Moses bespeaks the relevance and deep affinity of Platonism to Jewish-Christian thought.

[2069] For a sensitive and sensible appreciation of the more positive aspects of the interaction between Platonism and Christianity, see [Voge86]. Cf. also [Iván64] and [Omea82].

[2070] See [Camu87].

[2071] Pressing the metaphor a little further, the Christian apologist may want to add that modernism, also much like the black mass, will leave its adepts bereft and mentally frozen or sick, as they choose to forfeit the reality of God's loving grace for the pseudo-reality of the Prince of Darkness, built of distortions, hatred, and lies, empty of salvific power.

[2072] Important studies of this process of progressive deformation and immanentisation of the Western religious-spiritual legacy, or of various aspects of it, include [Funk86], [McKn89], [McKn91], [Midg94], [Dijk86], [Nobl99], and [Davi98]. Of particular significance for the immanentist thrust were probably the semi-pantheist or ubiquitarian conceptions of infinite space as a divine medium, body of God, or, as in Newton's speculations, a *sensorium Dei,* growing popular after the Cusanian-Copernican blast of the "shell" around the Empyrean abode of God, as though, this demarcation removed, the divine substance had somehow been homogenised all over space. The Platonist speculations on the *anima* and *spiritus mundi* – prominent in Henry More, Cudworth, Newton, Shaftesbury, and Ramsay – were germane to these pantheistic tendencies as were certain emanationist ideas of the Kabbalah, providing yet another paradoxical link between the Platonic-Cabalistic-Hermetic underground traditions and the Enlightenment thrust towards immanentisation. See [Koyr58], [Jamm93], [Fier53], [Cope80], [Henr79], [Walk72] p. 257 et seqq., [McGu77], [Dobb88], [Cope78], and [Samb71] p. 21 et seqq.

Taking immanentisation into account, it will also be easy to unveil the fundamental affinity, not to say equivalence, of ancient Gnosticism (including medieval Catharism) and various modern perceptions and sentiments, in particular as coming to the fore in movements such as positivism and secular humanism, for example concerning: 1) the basic turpitude of reality and existence, 2) the wickedness and irrelevance of the Creator, who, in a final gesture of affront, is immanentised into such amoral, impersonal concepts as chance, necessity, the laws of nature, and the like, 3) the reciprocal proclamation of the goodness of man's inclinations and caprices and the denial of his fall and guilt, which are replaced by the guilt of the Creator, who even after His ostensible abolishment is somehow paradoxically held responsible for all the evils that befall the blameless victim *man* (cf. [Gira01] p. 161 et seqq.), 4) the rebellion against reality as man's proper response to the insult of existence, 5) the bifurcation of moral standards into the ascetic-ideological perfection of the élite and the profligacy of the mass of worshippers of this élite, 6) the aversion to human life, leading to the assent to suicide (cf. the sacrament of the *endura* amongst the Cathars), birth control, abortion, euthanasia, and all kinds of perversions, which, besides serving as acts of rebellion against God and reality, prevent the further production of life, 7) *docetism,* or the belief that reality as it appears to us is only a deceptive mirage created by the sinister, shadowy forces of a more genuinely real reality, be it the aeons and archons of ancient Gnosticism or the laws of nature and elementary particles of modern science, 8) fierce anti-Christianism, showing in the hatred against the 'institutional' Church, orthodoxy, Christian morality, the Christ of the Gospels, priests, the pope, etc.

[2073] Q.v. in [Mull85].

- *unitas,* unity
- *simplicitas,* simplicity
- *aseitas,* self-existence
- *infinitas,* infinity
- *immutabilitas,* immutability
- *immensitas,* immeasurability
- *omnipraesentia,* omnipresence
- *perfectio,* perfection
- *aeternitas,* eternity
- *independentia,* independence
- *necessitas,* necessity
- *omnisufficientia,* self-sufficiency
- *primitas,* primacy
- *beatitudo,* beatitude
- *fidelitas,* fidelity or faithfulness
- *gloria,* glory, splendour
- *immortalitas,* immortality
- *lux,* light
- *magnitudo,* greatness
- *maiestas,* majesty
- *omnipotentia,* omnipotence
- *sanctitas,* sanctity
- *spiritualitas,* spirituality
- *invisibilitas,* invisibility
- *vita,* life

Some of these attributes may of course need re-interpretation, qualification, or modification when transferred from the nature of the divine to the modern conception of just "nature": For instance, *unity* and *simplicity* may be predicated of nature regarded as a whole, notably when speaking of the search for a "grand unifying theory", but may also be questioned or denied. The attribute of *immeasurability* may be challenged by some cosmologists, who believe themselves to know the actual dimensions of the universe, but will be assented to by others, who wish to proclaim the grandeur of nature and the universe or presume that there are other universes as well as ours, inaccessible to us. *Spirituality* and its corollary *invisibility* may be applied to the laws of nature themselves, but of course not to the material aspects of nature. Attributes such as *beatitude, glory, majesty, sanctity* may be promulgated with reference to "nature" by those moved by the grandeur of the universe, but will be declined by those of a more gnostic mind-set, who perhaps also, following Boltzmann, want to deny the universe *immortality* by referring to its slow progression against a future state of "heat death". *Life* is attributed to nature insofar as it is believed to spontaneously emerge from its basic set-up rather than being bestowed upon the living beings by God.

Of the other divine attributes, those of a personal, psychological, or moral character will not be easily attributed to an entirely impersonal "nature", but have instead been appropriated by modern, scientific man in the process self-divinisation. Amongst these man-appropriated attributes are:

- *omniscientia,* omniscience
- *omnisapientia,* omnisapience
- *voluntas,* will

Indeed, the history of Western intellectual life can largely be interpreted as the history of the ascent of man's will and his growing belief in his own omniscience and omnisapience. Concomitantly, there has been an ever-increasing stampede from the feelings of guilt and sin that used to trouble Christian man – and indeed a very large portion of men living in pre-scientific cultures, be they Christian or not –, presently often depicted as the deplorable outcome of a Christian conspiracy against man's happy self-assertion or of St. Augustine's bad conscience and noxious vagaries of thought. Little wonder if modern man deems himself capable also of the *virtutes Dei,* the divine virtues, without effort:

- *bonitas,* goodness
- *felicitas,* felicity
- *iustitia,* justice
- *veracitas,* veracity

The *affectus voluntatis Dei,* the affections of the divine will seem to be even more easily transferable to man, being reflected at least to some extent in his very nature also according to the Christian conception of man as made in God's image:

- *amor,* love
- *benevolentia,* benevolence
- *clementia,* clemency
- *gratia,* grace or goodness
- *ira,* wrath (viz. against sin)
- *odium,* hatred (viz. of sin)
- *longanimitas,* longsuffering
- *misericordia,* mercy
- *patientia,* patience

God's wrath and hatred of sin having been replaced by modern man's wrath and hatred of crimes against "the rights of man" – especially if "man" happens to be oneself, one's cronies, or someone one likes – and all kinds of real or imagined felonies and injustices of human existence, man, sure of his own capability for perfection and justice, now lays claim to these affections as something more or less congenital and natural to himself and no longer the elusive goals of perfection to be humbly searched for by the toils and struggles of sanctification. Even modern democracy with its ideals of equality, fraternity, liberty, etc. seems to be predicated on an immanentisation or, perhaps rather, a dreadfully twisted and garbled parody of Christian ethics and, in particular, of the paragon provided by the early Christian communities in Jerusalem and elsewhere with their ideals of Christian brotherhood and property-sharing. All in all, God is now deprived of personality and transformed into impersonal Nature, whereas modern man, by denying his own sinful nature, believes himself to become God and society and the state a new Eden.[2074]

Long before man had made bold to reclaim the righteousness, holiness, and wisdom – the so-called "principal perfections" of the soul – held to have been lost through the original sin, the station of man in nature was found to leave a great deal to be desired, at least when compared to his pre-Adamite glory.[2075] In the general aims and purposes of science, medicine, and technology, we can see the aspiration to do away with these deficiencies through the immanentisation of the three secondary prelapsarian perfections:

- freedom from suffering
- immortality
- domination of creation

In fact, the restoration of these prelapsarian "perfections", constituting the pivot of the wide-ranging Faustian agenda forged during the early modern era for the vindication and the realisation through restless human technoscientific and political activity of the immanentised millennial expectations rampant at this time, was made the very purpose of the scientific-technological revolution as originally outlined by Francis Bacon in his *Instauratio Magna.*[2076]

If the founding objective of technoscience in fact was to regain Eden and build the New Jerusalem on Earth, it should not be difficult to amass examples of how immanentised Jewish-Christian ideas inform and imbue present-day science. For one thing, scientific progressivism and the Big Bang and evolution theories can easily be identified as immanentisations of the Genesis creation story, the Christian linear-eschatological approach to history, and the Christian notion of God's providential care, as has already been argued above.[2077]

[2074] It would be interesting to try to relate this modern retreat from guilt and plunge into nihilist shame- and guiltlessness to the purported development from "shame-culture" to "guilt-culture" that [Dodd73a] p. 28 et seqq. places at the very outset of Western culture.

[2075] See [Mull85] p. 144.

[2076] To the perfections proper were also added various other features often claimed to be part of man's prelapsarian form of existence, such as abundance of food, the capability to control the world by magic, the power to fly through the air and to radiate light, knowledge of all the secrets of nature, etc. See [Webs75], [Ross68], [Yate75] p. 155 et seqq., and [Naue65] p. 48 and p. 284. It has been proposed that Francis Bacon's plans for an *instauratio magna* was inspired by the millenarian Orientalist and Cabalist Guillaume Postel's eccentric ideas about the *instauratio omnium,* put forth in his widely read prophetic manifesto *Panthenosia.* As suggested already in 1623 by Gabriel Naudé in his *Instruction à la France*, Postel, in turn, seems to have revived Roger Bacon's age-old programme for the restoration of the arts. Together with Paracelsus, Postel will have been the prime spiritual father (or perhaps rather grandfather) of the "Rosicrucian Enlightenment" of the early 17th century. See [Kunt81] p. 173 et seqq. et passim and [Åker98] p. 173 et seqq. and p. 214. Additionally, [Coud99] p. 347 et seqq. points out that the somewhat similar idea of *tikkun,* restoration, in the Lurianic Kabbalah also gestated at about this time makes man's activities crucial for the restoration of the creation. Id. op. p. 311 et seqq. also hints at the interesting possibility that this doctrine might have made an impact on Leibniz' proto-evolutionist conception of progress.

[2077] See footnote 1621 on p. 335.

In technology, the pervasive backdrop of religious and, to a no less considerable extent, magical-occult concepts and structures of thought is also detectable everywhere, although the true origin and nature of the seminal ideas are often obscured by the pedestrian character inventions and technical features tend to take on, as we integrate them with our daily routines. Nonetheless, we may more or less dimly recognise the ancient conceptions of soul travel and levitation behind the dreams that gave rise to aerospace and space technology[2078], the notion of telepathy behind the telegraph and the telephone, clairvoyance and apparitions behind the motion picture and television, the hope for immortality behind nanotechnology[2079], or the notion of spirit – or, perhaps, the Holy Spirit – behind the enthusiasm for electricity in the 19th century[2080], we may see the image of the heavenly city as a kind of archetype of the modern secular city, which, albeit in a terribly warped manner, seems to ape the splendours of its heavenly prototype by its monstrosities of glass and concrete and by its floods of artificial light, or we may apprehend the Christian notion of the resurrection of the dead as the seed of such an eccentric pursuit as cryogenics. We may of course press this kind of analogy further, seeing, for instance, with the philosopher David Stove the recrudescence of the notion of possession by evil spirits in Richard Dawkins' pop-Darwinist theory of *memes*[2081], descrying with the anarchist author R. A. Wilson a "new Inquisition" in today's ubiquitous scientistic dogmatism[2082], or with the historian of science Paul Feyerabend making out science itself as a kind of Church with its own dogma, bishops, and cardinals[2083], although we surely should beware of overdoing such metaphorical interpretation, which easily lends itself to both exaggeration and tedious over-schematisation.

We have above attempted to establish the main lineaments of the process of immanentisation, which we will now briefly recapitulate. *Gnosticism* – taken in the sense used by Voegelin, as a thought structure – instilled a thoroughgoing, rebellious discontent with the present state of the world, immanentist *millenarian apocalypticism* and *utopianism,* yoked together with the Gnostic outlook by the Ismaili revolutionaries, supplied the belief that this bad world can and should be transformed, *consolidated state power,* liberated from the ethical supervision of a strong Christian Church, rendered the projects of transformation increasingly plausible, *nominalism* made all things look arbitrary, contingent, shorn of essence and substance, determinable only by inspection and experiment, and susceptible to almost any conceivable kind of change and manipulation, *enthusiasm* imparted the proud certainty of man's own eminence, infallibility, and freedom from moral shackles, and *prisca theologia, Hermetic occultism,* and *magic* provided men both with the confidence, however elusive, in the feasibility of the desired innerworldly change and with the mindset necessary to embark on such endeavours – a mindset comprising, *inter alia,* a much strengthened will to manipulate this world, a temper of magic-scientific "experimentalism", a heady Faustian neophilia, and a sense of liberation from religious scruples and Christian compunction. The inoculation of this *olla podrida* of extraneous attitudes and tendencies on Christianity brought about a massive immanentisation both of the contents of Christian belief and of the surviving or revived rests of ancient paganism. The ultimate upshot of the thrust towards nominalism and immanentisation was the denial of essence, substantiality, and personality to all things, firstly to God, who was transformed from the living God of Christianity via the philosophical-pantheist 'absolute' to sheer dead 'nature', and then, secondly, to man, who albeit initially seemingly appropriating the divine glory for himself, immediately subsequent to his proud proclamation of himself as divine turns out to have become not God, but an empty nominalist shell and construction, a chimera conjured up by the demonic forces of biology (Darwin), politics (Marx), the subconscious (Freud), the appetite for power (Nietzsche), or some other reductionist idol promulgated by this or that gnostic prophet or 'maître du soupçon'. Paradoxically, modern man, having liberated himself from the divine and ecclesiastical 'tyranny' so resented by the gnostic rebels, turned out to have lost his soul in the bargain, being transmuted from a being created in the image of God into a nihilist zombie, T.S. Elliot's "hollow man".[2084]

[2078] Cf. [Cohe66] p. 95 et seqq. and [Heim93] p. 118 et seqq.

[2079] See below p. 490.

[2080] See [Benz89]. Cf. also [Davi98] p. 39 et seqq.

[2081] See [Font].

[2082] [Wils91]

[2083] [Feye80]. Cf. also [Maho76] p. 10 et seq.

[2084] It may be interesting to contemplate the question why, in spite of many remarkably gnostic and nominalist traits, Indian and, in particular, Indian Buddhist thought did not cause the kind of frantic attempts to reconstruct reality typical of the West. Although this issue would need considerable exploration to be properly understood, it seems reasonable to guess that the extraordinary freneticism of

As well made out by, amongst others, Spengler and Sorokin[2085], the state of a culture's soul is nowhere more conspicuous than in its works of art, architecture, and literature, which, being the objectivations of its spiritual life, will reveal through the artists' nisus its innermost meanings and profundities much better than any descriptive descant, however flowery and longwinded, can do. From the Renaissance onwards, the distressing story of the progressive loss of soul in Western culture can be closely tracked in the increasingly sensationalistic and impotent artistic expressions of our civilisation, as it grows more and more thisworldly, imitative, and superficially naturalist and sensualist, although it for some time still remained capable of producing impressive works of art through the lasting vigour of the Christian faith both in popular piety and in the hearts of many educated men and through the inner tension between the Christian faith and various aspects of the – admittedly in essence rather artificial and often pedantically erudite – recrudescence of ancient heathen culture. With the gradual loss of this tension amongst the élites of the 17th and 18th centuries through the 'enlightened' establishment of the modern constitution and the ensuing Romantic-sentimental, but at heart dissimulating and hypocritical reaction to this, Western culture and its artistic expressions turned evermore decadent, as is easily discerned in the flippant imitations of imitations, strangely mixed styles, and formally perfected and intriguingly calculated manifestations of artistry and virtuosity, which, albeit impressive at first, on closer examination cannot, however, conceal the sad lack of depth and authenticity characteristic of man increasingly immersed in the cult of his own shallow self rather than in an earnest quest for the depths of the divine truth. Out of the nihilistic maelstrom of the late 19th century were then eventually tossed up the depraved absurdities of modern art, literature, and architecture, largely being the outcome of a desperate chase for at least some trifle of interest and comment from a jaded and yawning élite of professional arbiters, scholiasts, and blatherskites by dint of all kinds of ignoble and perverse shock effects – to say nothing of the abysmal nullity of pop culture, the plastic skin of anodyne mass produced artefacts, in which modern man has enmeshed himself, and the utilitarian brutality of the modern functionalist landscape and townscape, the hideous unsightliness of which seems to be designed as yet another Promethean outrage against the aesthetical perfection of the divine creation, that foremost "signal of transcendence"[2086] so hateful to the 'enlightened' Gnostic goblin, into whom modern man has reduced himself, by reminding him that he through his own *incurvatio in se* has cut himself off from the splendour and glory of the well-springs of existence.

When the transcendental God, having been folded into nature and man, seemingly disappears and nature and man thus take His pride of place, one noticeable result is of course that God's jurisdiction is exchanged for man's freedom to do as he likes, as pointed out in the popular saw, "if God does not exist, anything is permitted".[2087] Indeed, antinomian freedom-assertion is an essential constituent of the modern constitution, as man is guaranteed almost unlimited freedom – at least as long as he does not challenge state powers or jeopardise the security and property of his neighbours – through the denial of the existence of God. In fact, this very point seems to be enshrined in the story of the original sin in *Genesis 3,* as the serpent lures Eve to disobey God's command by the promise that the first couple would through this act of disobedience and denial of God "be as gods, knowing good and evil". Antinomian self-assertion is also a recurrent theme – and to many adepts certainly a major allure – of Gnosticism all from the antitactic Gnosticism of the ancient Simonians, Nicolaites, Carpocratians, Ophites (i.e. the serpent-worshippers), Cainites, Phibionites, Borborites, over the later Messalinians and Paulicians and the medieval Bogomile, Cathar, and Albigensian heresies up to the contemporary neo-Gnosticism of the counterculture and various fashionable sects and fads.[2088] Likewise,

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the West stems from a peculiar Western form of Faustian anti-Christianism and, in particular, from the kind of immanentist millenarianism that provides the demonic reversion of true Christian eschatology.

[2085] See [Spen97] and [Soro37]. Cf. also [Scha68a] p. 9 et seqq.

[2086] [Berg90a] p. 59. Cf. also [Duba99]. For a few remarks on the Gnostic-occult background of modern architecture, see [Scha90] p. 96 et seqq. Cf. also [Jone95a].

[2087] This saying is generally attributed to Dostoyevsky, but according to [Cort99] it is nowhere to be found in his works, at least not in this particular wording.

[2088] A more or less prominent element of *anomie* is also part of the picture in, for example, many extreme forms of enthusiast or millenarian spirituality, the adepts of which believe themselves to have reached such immunity to sin by virtue of their lofty spirituality that they can perform any immoral act with impunity, and in the pursuits of Hermetic-occult magic, witchcraft, and the like. Notably, Gnostic freedom from the pangs of conscience also comes in handy for modern scientists and engineers, who in real life frequently have to put up with the unpalatable work on morally dubious pursuits, such as the development of homicidal weaponry, cruel experiments with animals, wilful neglect of environmental and human concerns, and the like. Even the Reformers largely seem to have secured their success by concessions to *anomie,* promising the princes freedom from the ecclesiastical supervision of the moral quality of their actions and the clergy from the hardships of celibacy. For political reasons, Luther even authorised Philip of Hesse's request for committing bigamy!

the Gnostic denial of the goodness of the Creator as revealed in His creation has been made the pivot of the modernist case against the existence of God.[2089] This denial is the starting point and *conditio sine qua non* of all the modern projects of reconstruction of the world, society, and man, be they political, scientific-technological, philosophical, psychological, or whatsoever in nature.

Earlier, I promised to attempt to adumbrate why the Darwinist theories have come to such prominence and are defended with such dogged tenacity by their own advocates, in spite of their intrinsic absurdity and counterfactuality, which a somewhat closer inspection of the facts at hand and some reflection will infallibly reveal to the honest and disinterested student of the matter – at least insofar as he is capable of freeing himself from the bewitchment of consensus reality and the vitriolic and intimidating cant of the Darwinist propaganda machinery. We can now see that Darwinism is an essential building block of the modern constitution, the deeper meaning of which is to depose God so as to set men – and, in particular, the various self-styled élites and spiritual brotherhoods confident that their own destiny is to bring out an upcoming era of innerworldly transfiguration – free to pursue whatever projects that are to their own liking.[2090] The Darwinist immanentisation of the riddle of creation and abolition of final causes are necessary to make such gnostic reconstruction projects plausible, since a transcendental origin of being and the omnipresence and continuous infusion of divine wisdom in being will make any attempts by man to change the order of being look not only futile and fatuous, but pregnant with disaster. As for Charles Darwin himself, there is a perceptible affinity between the Gnostic-Manichaean outlook of old and his bleak, anaesthetic conception of the world, hypersensitivity to suffering and death, and tormented mental life, revealed in his notebooks and correspondence as well as by his recurrent fits of various psychosomatic ailments.[2091]

Although a work of unabashed Catholic apologetic intention and aimed at a popular readership, [Ohar87] is very elucidating as to Luther's hideous arrogance and uncouthness, his dubious character, and his confused theological arbitrariness and duplicitousness.

[2089] See [Bill36] and [Bill52].

[2090] To those of us who do not share in the underlying gnostic, anti-theistic assumptions of the modern constitution, the freedom and opulence held out as grand promises by modernism will of course be nothing but grand shams. From our point of view, modern man, deprived of almost every trace of genuine insight into the spiritual basis of his own existence and reduced to "mass man", locked up in a labyrinth of innerworldly phantasmagorias and allurements and entranced by the hallucination of himself and the cosmos as amoral machines, will become neither free, nor liberated, but instead paradoxically enchained to his own appetites, to mad and demonic ideologies, and to the monstrous power systems into which any state, science, technology, economy, or other control system shutting itself off from the divine source will by necessity degenerate, possibly clever at giving man more than enough of *panem et circenses,* albeit altogether incapable of helping him to find authentic meaning, truth, and insight into his own rôle in the universe, to say nothing of salvation for his soul. Likewise, the political, journalistic, scientific, industrial, economic and other élites seemingly in control of these systems, although having deluded themselves into the belief in their own power and insight, are, from this standpoint, no less the slaves of their own vicious illusions, vices, and deleterious organisations than those they superciliously think themselves authorised to manipulate and control.

[2091] See [DM91] and [Hunt01]. Cf. also [Flem61] and [Brow86]. Darwin also made some confessions of a peculiarly gnostic note in his autobiography (see [DH83] p. 83 et seq.) as to his own loss of delight in poetry, scenery, and music and the transformation of his mind into "a kind of machine for grinding general laws out of large collections of facts". As an aside, Darwin's argument against God's omnipotence from parasitism (see [DM91] p. 293 et seq. and p. 479) is oddly reminiscent of the Gnostic heresiarch Marcion's arguments against the goodness of the Creator from the omnipresence of vermin and parasites in the creation. Darwin's Romantic toying with the idea of himself as the "devil's chaplain" (see index of [DM91]) and author of the "devil's gospel" (see [DM91] p. 489) also strikes familiar Gnostic chords. [Elia78a] vol. II p. 393 points out the affinities between ancient Manichaeism and modern scientific materialism in their attribution of the creation of the world to a chance happening – an idea that Mani probably appropriated from Bardesanes of Edessa – and between the Manichaean creation myth with its revelry in abominable and shocking details and modern Freudianism. As for Darwin, his hypersensitivity to the sufferings in nature has a striking parallel in the Manichaean idea of *Christus patibilis,* the omnipresence of the suffering Christ in nature. The rather telltale diabolism of the queasy apostle of the "struggle for survival" is paralleled in the widespread Romantic *fascination de l'abîme,* toyed with in the works of, for example, Blake, Lord Byron, Shelley, Leopardi, Goethe, Victor Hugo, Baudelaire, Huysmans, Mark Twain, Strindberg, and the 19th century occultists and theosophers (see [Coul92] p. 251 et seqq., [AW01] p. 112 et seqq., [Russ86], [Morr92], and [Webb90]) as well as in many other "doctors of modernity", such as Nietzsche and Marx (see [Nort89] and [Payn68] p. 315 et seqq.), whose early poetry lays bare not widely known Faustian-Manichaean depths of the psyche of the apostle of Messianic class struggle (id. op. p. 57 et seqq.). In particular, a curious relief to Marx' later 'achievements' is provided by the blasphemous, very confused Gnostic-Satanistic poems – inspired, in his own formulation in one of these youthful pieces, *Spielmann,* by "Höllendunst" – sent with a special dedication to his own pious dying father on his birthday in 1837, including the fragment of the tragedy *Oulanem* (an anagram on Emanuel, the name the angel bade St. Mary to give to our Lord) dealing with topics such as the corruption of youths through sodomy and the wish of the eponymous character of the poem – plausibly to be construed as Marx' *alter ego* – to destroy being itself, "bald preß' ich Ewigkeit an's Herz und heule/ der Meschheit Riesenfluch in sie hinein" (see [Marx75] p. 615 et seqq.). In fact, Marx' Gnostic-Promethean hatred against man and being looks strikingly similar to de Sade's, and it seems that the words of [Russ86] p. 146 would suit the diabolic prophet of class war no less than the mad advocate of torture and murder for pleasure, "Whatever one thinks of Sade's practices, one must give him credit for taking the principles of atheistic relativism to their logical conclusion."

The Darwinist-humanistic projection of the dismal Gnostic outlook onto the history of nature is based on the supposition that history in its entirety can be fathomed and understood by man, although such a feat patently is far beyond man's pale. Only by diabolically blocking the open quest for truth and research into "dangerous" subjects can modern scientistic secularism, for which Darwinism provides the corner stone, secure its hegemony and its strange historical constructions be rendered plausible. Thus, it prohibits alternative discourses to be entertained and the questions to be raised or, at least, openly and fairly discussed that will unveil its own hollowness and lack of credibility, such as the issues of consciousness, the origin of man's soul, miracles and paranormal phenomena, the evidence for the survival of the human soul, the formidable perfection and complexity of life and the cosmos, and many other similar topics, the interest in which is instead denounced as "irrationalism", "obscurantism", "occultism", "religion", or some other denigratory term. In this way, truth is made to disappear by "the magic of the extreme", the baffling and scintillating, fundamentally anti-rational rhetoric, which Voegelin spotted in Hegel and Nietzsche, but which is as prominent in the deluge of propaganda that wells out from the self-proclaimed Cerberi of reason, the "Enlightenment tradition", scientism, positivism, "skepticism", Darwinism, neuromonism, secular humanism, atheism, agnosticism, etc. and innumerable other isms and ideologies of the same ilk.[2092]

There is a strong political subtext to all this immanentist agitation, the core elements of which have been traded down to us from the Enlightenment. The general purport hereof will be that by accepting these rhetorical constructions and gnostic fantasies man will be made liberated, enlightened, rational, tolerant, democratic, and wealthy, whereas God, Christian religion, and the *ancien régime* associated with traditional Christianity underpin an obsolete and oppressive mode of being characterised by moralism, intolerance, poverty, obscurantism, irrationality, religious violence and authoritarianism.[2093] Thus, the various elements of modernism are designed to countervail the pillars of traditional beliefs: Darwinist self-organisation is substituted for divine creation, progress for divine providence, self-salvation for divine grace, the subconscious for the spiritual world and the life of the spirit, modern self-deification and self-actualisation for Christian self-oblivion and humbleness, the Faustian magus/Übermensch/scientist for the Christian viator/saint/martyr, etc.

But what can the credibility be of such a Faustian agenda of bargaining the open quest for truth and God for the idols of freedom and affluence? And what can the legitimacy be of something that by itself is an antithesis to or a distortion of something else? And how can we trust a phenomenon that purports to offer an unbiased road to truth, but is in fact regulated by hidden political, philosophical, metaphysical, (anti-)religious, or even certain individuals' self-aggrandising agendas? Is there not in fact a mountain of fervently suppressed evidence in favour of the "traditional worldview", fatally undermining the much-vaunted "scientific worldview"? And if the tree is known by its fruit, does the fruit really testify to the advantage of technoscientific modernity? Has it not in fact become altogether evident by now that the modern project has precipitated the world into a cesspool of irresolvable problems and disastrous dilemmas, nay has set man on a catastrophic course?

2092 [Voeg77]

2093 See [Cony01].

ὁρᾷς ὅσα □πο□ησεν ’Αζαήλ, κα□ ὅσα ε□σήνεγκεν, ὅσα □δ□δαξεν, ἀδικ□ας κα□ ἁμαρτ□ας □π□ τῆς γῆς, κα□ πάντα δόλον □π□ τῆς ξηρᾶς. □δ□δαξε γὰρ τὰ μυστήρια κα□ ἀπεκάλυψε τῷ α□ῶνι τὰ □ν οὐρανῷ. □πιτηδεύουσι δὲ τὰ □πιτηδεύματα αὐτοῦ, ε□δ□ναι τὰ μυστήρια ο□ υ□ο□ τῶν ἀνθρώπων.

First Book of Enoch IX.6[2094]

Es ist demnach das Interesse der Wissenschaft, daß kein Gott sei – kein übernatürliches, außserweltliches, supramundanes Wesen. Nur unter dieser Bedingung, nämlich, daß allein Natur (diese also selbstständig und Alles in Allem) sei – kann die Wissenschaft ihr Ziel der Vollkommenheit zu erreichen; kann sie ihrem Gegenstande gleich, und selbst: Alles in Allem zu werden, sich schmeicheln.

Friedrich Heinrich Jacobi[2095]

And, finally, with the prodigious advancement of science since the seventeenth century, the new instrument of cognition would become, one is inclined to say inevitably, the symbolic vehicle of Gnostic truth. In the Gnostic speculation of scientism this particular variant reached its extreme when the positivist perfector of science replaced the era of Christ by the era of Comte. Scientism has remained to this day one of the strongest Gnostic movements in Western society; and the immanentist pride in science is so strong that even the special sciences have each left a distinguishable sediment in the variants of salvation through physics, economics, sociology, biology, and psychology.

Eric Voegelin[2096]

Yet, depending on how scientists judge the public's mood, they are more or less blunt about this epistemological imperialism. When feeling secure in their role as the cultural priesthood, they insist that naturalistic science has completely discredited the claims of religion. Tufts philosopher Daniel Dennett, in Darwin's Dangerous Idea, says Darwinian evolution is "a universal acid" that dissolves all traditional religious and moral beliefs. He suggests that traditional churches be relegated to "cultural zoos" for the amusement of onlookers. I witnessed the same attitude at a conference last April at Baylor University: Nobel prize-winner Steven Weinberg lumped together all spiritual teachings, whether of Buddha or Jesus, as talk about "fairies" A few months earlier he had told the Freedom From Religion Association, "I personally feel that the teaching of modern science is corrosive to religious belief, and I'm all for that." If science helps bring about the end of religion, he concluded, "it would be the most important contribution science could make."

Nancy Pearcey[2097]

Where does the ground covered in the previous sections take us as far as science is concerned? The meaning of *scientia,* science, is 'knowledge', but obviously modern science is much more than just knowledge. For one thing, science provides a social context that is part of what Sorokin called the "sociocultural supersystem" and Latour the "anthropological matrix", i.e. the intricate web of interrelationships that unites all aspects of a culture into some kind of a whole. In the modern world regulated by "the modern constitution"[2098], science has usurped the rôle, which the Church and the Christian religion used to play not too long ago, as the most widely respected authority and arbiter, regulating man's beliefs, opinions, and actions. As scientists are perforce guided in their various pursuits by a plethora of extrascientific, metaphysical presuppositions, there is no such thing as "pure science", let alone a neutral "scientific method" through which untainted, unassailable knowledge can be automatically and safely attained, but science always reflects the

[2094] [Char1893] p. 69 et seq. Cf. also [Char83] vol. 1 p. 17.

[2095] [Jaco26] p. 207

[2096] [Voeg87] p. 127

[2097] [Pear00]

[2098] See p. 416.

various concerns and convictions of its practitioners. Additionally, man, a being beset by his own desire for understanding, always strives to create mental maps of the world wherein he dwells. However, these maps, which surreptitiously control and bias all scientific research, can only be constructed by stepping outside the narrow constraints of knowledge proper so as to fill out the gaps of what is actually known. Consequently, two aspects of science can be distinguished, viz. *science as knowledge* (or *science proper)* and *science as ideology* (or *pseudo-science),* although these two aspects are in actuality inextricably interwoven, as indicated by the common wisdom that all scientific observation is theory-loaded.[2099]

Still, also the core of 'science proper', the recorded observations, experiments, reproducible phenomena, and various theoretical generalisations made from these, in brief the *bona fide* scientific knowledge, which, as suggested by such concepts as Scheler's *Leistungswissen* and Ellul's *technique*[2100]*,* primarily tends to concern the practically useful applications that provide the legitimisation of science, remains strongly metaphysically laden, being pervasively constrained and regulated by the ideological or pseudo-scientific portion of science. It should be underlined that by using the term *pseudo-science* to designate the more or less veiled metaphysical agendas, which, albeit not *per se* being *scientia,* knowledge, regulate the general course of scientific research and the production of scientific knowledge and provide the interpretational framework for the topics studied, I do not – as many other users of the word – intend to be derogatory, nor to disparagingly allude to the study of controversial phenomena such as UFOs, chakras, fairies, crop circles, acupuncture, and the like, which, in my view, will be both interesting and legitimate realms of study, not unlikely to generate important 'science as knowledge' if researched with proper care and prudence. Thus, the pseudo-scientific "penumbra of science"[2101] will comprise a wide variety of approaches, agendas, policies, and structures of thought, ranging from seemingly innocent, often tacit[2102] "methodological" precepts, values, rules of thumb, and guidelines concerned with what counts as "good science" within a certain domain of study to such wide-ranging, highly ideological thought systems as reductionism, positivism, physicalism, behaviourism, Darwinism, Marxism, Freudianism, just to name a few influential ideological starting-points for scientific pursuits. Although these isms may seem extremely divergent and some of them tend to provoke much suspicion and hostility with those not personally privy to them, the common denominator of almost all such pseudo-scientific agendas lies with their common roots in the radical, anti-Christian Enlightenment tradition of materialism, naturalism, atheism – or the somewhat softer Victorian "agnostic" variant hereof –, and in the total denial of the importance of spiritual realities – in short Poortman's *Alpha* standpoint.

The rather extraordinary naturalist-materialist bias amongst scientists also has another disturbing consequence. If the *Alpha* standpoint is embraced, there will be no reliable authority besides science itself, and science, or rather its pseudo-scientific penumbra, will naturally transmogrify into the kind of – often belligerently dogmatic – *ersatz* religion referred to as *scientism,* which makes science appear as a saviour coming down from heaven with the right answers and solutions to all issues rather than as the pedestrian and error-prone human activity it actually is. By falsely appearing as a disinterested arbiter of all kinds of issues, when in fact it reflects the metaphysical, religious, political, ethical, personal, and other predilections and hidden agendas of the members of scientific communities, who almost unexceptionally will be *a priori* deeply and unswervingly committed to a naturalist, often belligerently anti-religious and anti-Christian, ideology, today's science totally obscures reality, which, as we have argued above, cannot in the first place be plausibly held to be amenable to a naturalist interpretation at all, and makes the division line between scientific fact and scientific fiction extremely difficult to discern, paradoxically particularly so to the scientists themselves within their very own domains of expertise, as they, hamstrung by the narrow perspectives and the general lack of spiritual discernment fostered by the rule of 'specialism' as well as by the deceptive consensus achieved by the characteristic scientific habit of muzzling dissidents, become blind to how their own presuppositions condition this consensus and thus mistake this artificially created consensus for reality itself, as though reality was really something decided on by political intrigue and finesse. To many science becomes a kind of quasi-religion, providing a grand fairy-tale of how things came to be the way they are, but one shorn of the spiritual and ethical content that is at the heart of both true religion and true reality. By making science a salvific

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[2099] See [Hans65].

[2100] On Scheler's tripartition of knowledge into *Leistungswissen, Wesenswissen,* and *Erlösungswissen,* see above p. 321. Ellul explains his conception of *technique* and its relation to science in [Ellu64] p. 7 et seqq.

[2101] [Wals92] p. 142

[2102] See [Pola67].

pursuit, by bestowing upon scientists the resplendent status of a gnostic brotherhood of semi-divine pneumatici, who will help to bring about the grand immanentist transfiguration of the world, and, last, but not least, by securing for this brotherhood of almost superhuman warlocks the free reins – i.e. the liberty from the fetters of ethical restraint, compunction, and the like – and the wherewithal needed for the pursuit of its projects, the allure of scientism naturally becomes irresistible to many scientists. Although scientism has often been opposed and criticised, it has been able to ensure a strong grip not only on the scientists themselves, but also on the political-economical powers that be and the public at large, providing to both an *ersatz* religion in lieu of the traditional religion it struggles to dismantle and, through technology and medicine, many deceptively endearing benefits, by which the needed common assent to its pursuits is easily garnered.[2103]

Currently, the materialist-naturalist presuppositions characteristic of the scientistic agenda rule the roost unquestioned in most areas of scientific research and education at the exclusion of other approaches. For example, this is the case in the physical sciences ("physicalism", "reductionism"), the life sciences ("neo-Darwinism", "medical materialism", "neuromonism", "cognitivism"), in philosophy (almost all modern philosophy from positivism to postmodernism), nay even in theology ("liberal theology"). The academic pockets of opposition to naturalism are few and weak and often under violent attack from those who regard naturalism the bulwark against what they for one reason or other dislike. Indeed, the trepidation caused amongst scientists by the slightest signs of dissent is often so strong that suppression and prosecution are likely to befall anyone who happens to nourish a somewhat novel or unusual idea, which arouses the suspicion of the guardians of the pseudoscientific aims of science. Thus, science, much like Cronus and the revolution, tends to devour its own progeny.[2104] But even though naturalism and scientism have since the Enlightenment gradually strengthened their positions in the Western mind, outside the world of science and Academe there is no consensus about their meritoriousness, but rather a sea of simmering, grumbling misgivings and popular opposition.

Although contemporary Western thought may look like the battlefield of a confusing multitude of egophanic freebooters, most of these can – albeit admittedly somewhat simplistically and arbitrarily – be classed as belonging to one of three main categories, which we provisionally may call *traditional theism, mystical syncretism,* and *modernism:*[2105]

- *Traditional theism* will here be used to designate traditional, reasonably orthodox forms of Christianity, i.e. primarily Roman Catholic, Eastern Orthodox, and conservative Protestant Christianity, as well as orthodox forms of the Jewish and Moslem religions, all endorsing the *Delta* or *Epsilon* standpoint in Poortman's classification and being either *exclusivist* or *inclusivist* as to the validity of other outlooks. The mostly highly heterodox liberal and modernist varieties of Christian theology are more aptly classified as *modernism* or, in a few cases, *mystical syncretism.*

[2103] Through his landmark study of Bacon's philosophy [Mais1838], *Examen de la philosophie de Bacon,* Joseph de Maistre will stand out as the first to conceive a thoroughgoing critique of scientism, although his objections to the cult of science were not without precedents, for example, being prefigured, at least in some respects, by the contemporary critics of Hobbes' and Spinoza's atheism and Descartes' rationalism, such as Cudworth, Moore, Vico, and Comenius, as well as by Swift's caricatures of the scientific spirit, by Rousseau's, Blake's, and the Romantics' primitivism and mysticism, by Jacobi's remonstrance with the German philosophers, and by Burke's devastating appraisal of the revolution in France and the ideas behind it. Significant, more recent contributions to this genre will include [Shes70], [Lewi96a], [Voeg48], [Owen52], [Haye64], [Popp61], [SW60], [Barz64], [Rosz73], [Sore91], [Midg94], and [Milt96]. See also [Olso82], [Well44], [Aesc98], and [Pass78], whose attempt at a defence of science against its critics at times seems so weak that one becomes doubtful as to the author's allegiance to the views he purports to hold. Influential modern critiques of technology have been framed by, among others, Mumford (see [Mumf55] and [Mumf67]), Giedion (see [Gied69]), Heidegger (see [Heid74]), Hans Jonas (see [Jona84]), Ellul (see [Ellu64], [Ellu70], [Ellu85], and [Ellu90]), Winner (see [Winn77]), Barrett (see [Barr78] and [Barr86]), Postman (see [Post86], [Post92] [Post93], and [Post94]), Baudrillard (see [Baud90] and [Baud94]), and Mander (see [Mand91]). See [Mitc94] for a survey of the field of the philosophy of technology, [MM73] for a somewhat dated, but still valuable bibliography, and [Cutc00] for a concise introduction to the entire realm of *Science, Technology, and Society Studies,* which comprises the philosophy, history, and sociology of science and technology. Cf. also [Heim98] p. 33 et seqq. In Sweden, Tage Lindbom has forged a perceptive and highly penetrating critique of the modern cult of science and technology in his numerous writings; amongst other works in Swedish treating such topics are [Ahlb78], [Wrig86], and [Wrig93].

[2104] See footnote 1517 on p. 310.

[2105] As argued above, the roots of both *mystical syncretism* and *modernism* are to be found in the attempts – going back to the Middle Ages and the Renaissance – to reform Christianity through the revival of ancient pagan culture and philosophy, most importantly Aristotelianism, Platonism, and Hermeticism, although over time these attempts grew increasingly non-Christian and, then, anti-Christian and, finally, generally anti-religious. Cf. also footnote 1513 on p. 308.

- *Mystical syncretism* descends from the Renaissance attempts to create a kind of theosophical mystic-occult meta-religion put together from Christian Platonism, Hermeticism, and the Kabbalah, but adds various other elements to this heritage, from Eastern and modern philosophy as well as from modern science. It includes what is generally known as *New Age* spirituality, but also various older branches of the Platonic-Hermetic tree, currents referred to by terms such as occultism, transcendentalism, esotericism, perennialism, Romantic idealism, spiritualism, theosophy, etc., and certainly also much so-called "private religiosity". Whereas *New Agers* – much like the occultists of the 19th century – are often very keen on the harmonisation of science – and in particular evolutionism – with their own mystical-occult "spirituality", not seldom at the peril of ending up with some kind of "pop religion" or "pop science", the traditionalist camp, often referred to as *esoterism,* defends traditional religion and culture – albeit usually not singling out a particular religion – and tends to be suspicious of compromises between religion and scientific speculation in general and evolutionism in particular.[2106] The scope of metaphysical standpoints advocated by syncretists is very wide, ranging from the *Beta* to the *Zeta* standpoints, although with a marked predilection for the *Gamma, Delta,* and, in particular, *Zeta* ones. In fact, syncretists tend to be as prone to pass acrimonious strictures on Cartesian dualism (the *Epsilon* standpoint) as on materialist monism (the *Alpha* standpoint). As far as other religious outlooks are concerned, syncretists naturally lean towards *pluralism,* or, occasionally, *inclusivism,* although some advocates of neo-Gnostic, neo-pagan, feminist, and various similar 'fringe' views may inveigh so heavily against "dogmatic" religion in general and orthodox Christianity in particular that they tend to end up in *exclusivism.*

- *Modernism* in its different forms is first and foremost the child of Enlightenment rationalism and the rise of secular science, which both, in turn, are the children of Renaissance utopianism and occultism. Having scrapped both traditional religion and occult mysticism or, at most, re-interpreted them in terms of some kind of diluted innerworldly symbolism, modernists are strongly commited to monistic materialism and naturalism (the *Alpha* standpoint), and their attitude towards other points of view is usually arrogantly and belligerently *exclusivist.* Besides the staunchly rationalist varieties of the agenda, such as positivism, scientism, and "skepticism", the more radical forms of modernism, such as Marxian and National Socialism, Freudianism, existentialism, or Nietzschean nihilism and its postmodern regurgitation, tend to turn the built-in scepticism of the rationalist, anti-Christian agenda back onto science, rationality, and even itself, often ending up in a what amounts to a furious gnostic rebellion against reality itself, where the resulting pervasive nihilist cynicism is apt to either abolish both rationality and science altogether or to render them the tools of overtly irrational aspirations, such as Nietzsche's "will to power".

Obviously, there is little presence of either *traditional theists* or *mystical syncretists* in today's scientific-academic élites, which have more or less become the exclusive playing ground of *modernists.*[2107] This is hardly a

[2106] See [Hane98a] p. 384 et seqq. for a discussion of the somewhat fuzzy terminology used for the different branches of these intellectual currents. Present-day traditionalism has its roots in the Romantic reaction against the Enlightenment – although there are multiple connections to older forms of esotericism as well – and gained much momentum through the First World War, in the aftermath of which men like René Guénon, Frithjof Schuon, and Titus Burckhardt immersed themselves in non-Western, in particular Sufi and Hindoo, traditions, apparently largely as a kind of protest against the spiritual degeneration of the West that had become so obtrusively evident through the Great War (see [Rawl98] p. 20 et seqq. et passim). Whereas many of the leading personages of 20th century traditionalism, from Ivan Aguéli, René Guénon, and Frithjof Schuon to Huston Smith, have been initiates in the Shadhili Sufi order, earlier traditionalism, as represented by, for example, Joseph de Maistre, reacting in a similar way against the simplistic rationalism of the Enlightenment and the terrors of the French revolution, was predominately Romantic-Catholic in its orientation, although by no means immune to the charms of esotericism and perennialist mysticism.

[2107] That this is indeed so can be inferred from the Gallup polls tabulated in [Gall84] p. 168 et seqq., according to which, for instance, 16% of American élite scientists affirm and 68% deny a belief in life after death, whereas 67% of Americans in general support such a belief and only 27% dismiss it. Similar results are reported in [LW97b] and [LW98] (cf. also [LW99b]), where, additionally, a substantial difference between American élite scientists and rank and file scientists is recorded. For example, 39.3% of all scientists believe in God and 38.0% in human immortality, whereas only 7.0% and 7.9% of the élite scientists do so. [McCl84] p. 128 et seqq. (and [McCl82]) reports similar evidence with regard to a belief in extrasensory perception, drawing the following conclusion (p. 162):

"The population of elite scientists surveyed in this study demonstrated the highest level of skepticism over ESP of any major group surveyed within the last twenty years. This doubt in the probability of ESP is positively related to denying the legitimacy of parapsychology. In that this population of scientists constitutes an "administrative" elite, these results shed light on the reason

consequence of the lack of interest and merit of theistic and syncretistic perspectives, as the devotees of modernism would have it, but rather of the strong proclivity for dogmatic homogenisation and repression of dissidents inherent in the scientific culture, as uncovered by the sociology of science and well known by all scientific practitioners, who, consequently, tend to accommodate their own views to the monolithic belief system surrounding them or, in case they are unable to give up their dissident opinions, keep as quiet as possible about them. This predominance of naturalism, scientism, materialism, positivism, reductionism, atheism, secular humanism, modernism etc. – in short the Enlightenment agenda – in science, technology, and philosophy is, I submit, problematic for many reasons, some of which are:

1) *Lack of truth.* I have already argued at some length that naturalism is untenable as a metaphysical doctrine and that plentiful 'anomalies' exist that cannot be accommodated to a naturalist perspective, nay that our very existence as conscious observers of an intricately engineered cosmos is irreconcilable with it.[2108] As the various corpora of such anomalies will be of crucial importance for man's proper orientation in the world, the ban the adherents of naturalism try to put on the unbiased study of this counterevidence either by just disregarding it or by brushing it away by some knee-jerk verbal conjuration not only fatally undermines the open quest for truth, replacing it with the proclamation of naturalism as *the Truth,* but unveils the basically dogmatomachic character of naturalism, the legacy of its origins in the onslaught on the society of the *ancien régime* and on the Christian religious institutions, ideas, and life forms that were its soul. Thus, rather than embodying an open approach to being, naturalistic science provides the pseudo-rationalistic underpinnings of the various gnostic-political agendas concerned with the creation of an innerworldly quasi-paradise, Tage Lindbom's "människorike", the rule of man, and is pervasively conditioned by the aim of rendering these gnostic-modern agendas plausible and legitimate. However, this can only be achieved by sacrificing truth – through ruthless rhetoric, through the suppression or distortion of the portions of reality that endanger the naturalist constructions, and through the provincialism and excessive credulity as to the constructed consensus realities typical of today's over-specialised, unreservedly naturalistically committed sciences. Thus, naturalism and scientism end up in cognitive nihilism: "Nothing is true, everything is permitted."

2) *Lack of depth.* If the adoption of naturalism as the foundation of science implies the jettison of truth, it will hardly be surprising if naturalistic science, despite its *prima facie* overwhelming and seemingly compelling discourse and pretensions, on closer inspection strikes one as shallow, artificial, inadequate, one-sidedly instrumental, nay fundamentally skewed in its entire approach to being, and thus, in the end, misleading, demoralising, and untrustworthy. The modern, technoscientific fear of depth, substance, essence, personality, and God – i.e. the realms of *Wesenswissen* and *Erlösungswissen* – and obsession with the superficial aspects of being at the expense of the depths of the life of the spirit, notably with the measurable and material, with "primary qualities", with power and manipulation – i.e. its character of *Leistungswissen* –, seem to reflect a self-willed disconnection from the wellsprings of being, a demonic-Faustian preference for vacuity, darkness, and falsehood over real life, light, spirit, and truth, apparently the ultimate upshot of the occultist, nominalist, and immanentist roots of science.[2109] This scientistic sickness of mind, if we may make bold

parapsychology has failed to gain full legitimacy within the scientific community even though its proponents attempt to adhere to all the norms and canons of science. Within this group of elite scientists, belief in ESP is more closely related to personal experience than to familiarity with the research literature on psi. There is a tendency for those who doubt the existence of ESP to cite a priori reasons for this opinion. The frequency of anomalous experience reported by members of this population is highly and positively correlated to their belief in ESP. A far lower percentage of these elite scientists report anomalous experience than is reported by the American population."

Cf. also [Beck86], who surveys a number of studies, which he claims show that religious faith declines with intelligence. This conclusion, if correct, confirms that individuals who, scoring high at IQ tests, are likely to have immersed themselves in various scientific, intellectual, and ideological studies and activities to a significantly higher degree than those scoring low, will also tend to imbibe the predominately irreligious or anti-religious tenor of current Western scientific and intellectual life.

[2108] See p. 322 et seqq. Additionally, the perpetual changes in scientific interpretations and paradigms demonstrate that "science" is not some kind of safe strongbox of perennial knowledge, but rather an ever-changing stream of opinions and vogues, of fleeting theories and biased selections of 'facts'.

[2109] Cf. [Bolt84a] p. 216 et seqq.

to so denominate it, showing in a general arrogance against Christianity, religion in general, metaphysics, ethics, other ages, and other cultures and in a lack of sensibility and care for the most important things in life, is also reflected in the popularity of "scientific materialism", "secular humanism", "skepticism", positivism, Darwinism, and similar saturnine outlooks amongst scientists and engineers.[2110] Most conspicuously, the counterfeit of scientistic modernity is revealed through its lacking eschatology, that is to say its complete failure to cope with the fundamental terms of human existence as set down by the four last things, Death, Judgement, Heaven, and Hell, which are instead shirked, denied, or juggled away by rhetoric, ridicule, and the modern world's many artificial sedatives.[2111]

3) *Lack of ethical foundation and directives.* Whether we regard it as a major problem, a significant feature, just an appurtenance, or the very essence of naturalism, the tremendous troubles in formulating a credible ethical agenda based on naturalism can hardly be questioned.[2112]

2110 One may here call attention to Jacques Ellul's incisive observation in [Ellu64] p. 434 et seqq. on the stultifying impact of *technique* on the élite no less than on the rank and file of science and technology through the excessive concentration on some single, narrowly defined topic at the expense of other sensibilities in the interest of utilitarian efficiency and an exclusively instrumental rationality, which one-sidedness tends to make also scientific experts celebrated as geniuses in their own field appear naïve and platitudinous as soon as they have to comment on anything outside their own range of expertise. Similar reflections are found in [Mali87] p. 33 et seqq., who also comments on the just as miserable spirit of the humanities, which he characterises as ruled by naturalism, subjectivism, rationalism, scepticism, analysis, idealism, materialism, technologism, futurism, cynicism, nihilism, Freudianism, relativism, voluntarism, "change", "in a hurry", (secular) humanism, monism, immanentism, secularism, and atheism. Cf. also the amusing portrayal of scientists in [Stan50] p. 25 et seqq. These observations may also remind us of Pascal's famous characterisation of the intuitive and mathematical mind in [Pasc97] section 1.1, which I take the liberty to quote in full:

"The difference between the mathematical and the intuitive mind.--In the one, the principles are palpable, but removed from ordinary use; so that for want of habit it is difficult to turn one's mind in that direction: but if one turns it thither ever so little, one sees the principles fully, and one must have a quite inaccurate mind who reasons wrongly from principles so plain that it is almost impossible they should escape notice. But in the intuitive mind the principles are found in common use and are before the eyes of everybody. One has only to look, and no effort is necessary; it is only a question of good eyesight, but it must be good, for the principles are so subtle and so numerous that it is almost impossible but that some escape notice. Now the omission of one principle leads to error; thus one must have very clear sight to see all the principles and, in the next place, an accurate mind not to draw false deductions from known principles. All mathematicians would then be intuitive if they had clear sight, for they do not reason incorrectly from principles known to them; and intuitive minds would be mathematical if they could turn their eyes to the principles of mathematics to which they are unused.

The reason, therefore, that some intuitive minds are not mathematical is that they cannot at all turn their attention to the principles of mathematics. But the reason that mathematicians are not intuitive is that they do not see what is before them, and that, accustomed to the exact and plain principles of mathematics, and not reasoning till they have well inspected and arranged their principles, they are lost in matters of intuition where the principles do not allow of such arrangement. They are scarcely seen; they are felt rather than seen; there is the greatest difficulty in making them felt by those who do not of themselves perceive them. These principles are so fine and so numerous that a very delicate and very clear sense is needed to perceive them, and to judge rightly and justly when they are perceived, without for the most part being able to demonstrate them in order as in mathematics, because the principles are not known to us in the same way, and because it would be an endless matter to undertake it. We must see the matter at once, at one glance, and not by a process of reasoning, at least to a certain degree. And thus it is rare that mathematicians are intuitive and that men of intuition are mathematicians, because mathematicians wish to treat matters of intuition mathematically and make themselves ridiculous, wishing to begin with definitions and then with axioms, which is not the way to proceed in this kind of reasoning. Not that the mind does not do so, but it does it tacitly, naturally, and without technical rules; for the expression of it is beyond all men, and only a few can feel it.

Intuitive minds, on the contrary, being thus accustomed to judge at a single glance, are so astonished when they are presented with propositions of which they understand nothing, and the way to which is through definitions and axioms so sterile, and which they are not accustomed to see thus in detail, that they are repelled and disheartened. But dull minds are never either intuitive or mathematical. Mathematicians who are only mathematicians have exact minds, provided all things are explained to them by means of definitions and axioms; otherwise they are inaccurate and insufferable, for they are only right when the principles are quite clear. And men of intuition who are only intuitive cannot have the patience to reach to first principles of things speculative and conceptual, which they have never seen in the world and which are altogether out of the common."

2111 Hardly much better than this blunt denial of the human condition is the re-construction of eschatology into some romantic, sickly sweet, or mawkish, but in effect deeply demoralising vision of the soul's incessant progress through different "planes of existence", as, for example, is done in much of the occultist, theosophical, spiritist, New Age, liberal theology, neo-pagan etc. literature on near-death experiences, reincarnation, and suchlike. For some incisive remarks on the spiritualist variant of the "continual progress" theory, see [Raup20] p. 146 et seqq. Cf. also [Sabo98] p. 193 et seqq.

2112 Through the adoption of "the modern constitution" and the "suspension of the anthropological matrix", ethics lost the objectivity that ensued from its grounding in divine law and became a matter of subjective opinion, something to be opted for by each individual himself or by plebiscites, political bodies, committees, contracts, the mob, a Führer, and suchlike. Indeed, atheism, materialism, and naturalism have – *pace* Bayle's virtuous atheists – always been closely associated with moral arbitrariness, debauchery, criminality, and *anomie*. Thus, the attempts to rescue some smithereens of Christian (and/or pre-Christian) morality through such devices as the Kantian categorical imperative, Hobbes' and Rousseau's social contract, or various utilitarian, eudemonist, pragmatist, or humanist schemes all

Since the establishment of the 'modern constitution' in the 17^{th} and 18^{th} centuries, the very lack of ethical restraints, consequential upon the modern adoption of naturalist metaphysics, has permitted an increasingly Faustian technoscience to bring forth an endless cavalcade of innovations – intellectual, scientific, and technical – without any noticeable concern for the consequences – in glaring contrast to the state of affairs in the pre-scientific, pre-modern era, when innovations generally met with incredulity and questioning resistance. Arguably, this permanent technoscientific reconstruction of the world amounts to nothing less than a full-scale utopian experiment with humanity, the biosphere, and the Earth at stake, the outcome of which presently seems, to put it mildly, as doubtful as its records distressing.

4) *Lack of rational mechanism.* The lack of ethical grounding following from the adoption of naturalism as the metaphysics of science shows also in the depravity and irrationality of the inner life of science, as unveiled by Kuhn and the sociologists of science and well known by anyone privy to scientific-academic life.[2113] In particular, Kuhn's picture of 'normal science', as pursued between the infrequent and brief revolutionary caesurae of innovation, reveals the mechanisms of 'scientific progress' as an abyss of petty games of puzzle solving, hide-bound prejudices, irrational dogmatism, suppression of dissidents, intemperate infighting, unscrupulous nepotism, and shabby cabals, all ruled by what Lakatos aptly called "mob psychology"[2114] – in short the sad state into which man falls when deprived of a reliable ethical foundation to lead his life by. Although this disquieting image has been widely acknowledged as essentially true to life, scientists have shown little concern, contrition, or interest in pursuing a debate on the possibility of a reform of science for the better.[2115] On the contrary, this dismal image often seems to have provided a kind of paradoxical legitimisation for the perseverance of scientists in doubtful or irrational behaviour, because 'this is the way science works', as the saying goes. From a more theoretical point of view, both the sociological study of scientists and the philosophical debate about science have scuttled the credibility of the notion of a magic, universal "scientific method", which now appears as but a grand spectre, conjured up by the propagandists of scientism and positivism of yore. "The experimenter effect" discovered by psychical researchers and psychologists, the breakdown of the scientific concept of causality implied by experiments in quantum physics and by the parapsychological evidence for retroactive psychokinesis and precognition, and the doubt cast by the sociologists of science on such cornerstones of the scientific procedure as the crucial and repeatable experiment further invalidate the alleged rationality of the scientific project.[2116] In addition, the prevalent fragmentation and specialism of science as well as its aggressively defended metaphysical bias further undermine its credibility as an unbiased, rational-objective approach to truth.[2117] No wonder

come out as futile, unconvincing, and impotent intellectual constructs – rather it is de Sade, Marx, Freud, Nietzsche, Lenin, Hitler, Stalin, Mao, and Pol Pot, who have revealed the true moral consequences of naturalism. As has often been pointed out, the issue with naturalist ethics is not that materialists, atheists, and nihilists are always and automatically behaving amorally or wickedly, but that they have no foundation for moral behaviour and, thus, defer virtue, which cannot *per se* have any clear meaning in a naturalist conception of the world, to personal whim. The detrimental effects of "the language of science" and modern Academe on society and civic morality is charted in [Schw86]; cf. also [Smit91] and [Bloo87]. In addition, [Voeg66] provides a brilliant analysis of the catastrophic ramifications of von Humboldt's idea of the university with its immanentist, egophanic humanism, its divinisation of man and, in particular, of the genius or master thinker, and its abscission of the transcendental and spiritual, as reflected in its prestige words "Bildung", "Originalität", "Individualität", "inneres Dasein", etc.

2113 See, for example, [Kuhn70], [Mali87], [MD77], and [Barb61]. We touched upon this topic in a previous section (see p. 8 above). Cf. also footnote 1517 on p. 310.

2114 [Laka65] p. 178

2115 The most notable exception will be Feyerabend's well-argued calls for a pluralistic science (most importantly in [Feye93]), which, predictably, met with widespread alarm in the scientific establishment.

2116 On the "experimenter effect", see footnote 1500 on p. 304. The notion of the "repeatable experiment" is given short shrift in [Coll85]. The perverse subjectivity, "confirmatory bias", and favouritism fostered by the "peer review" system have been widely documented – see, for example, [Maho77], [Maho76] p. 83 et seqq., and [CH90]. In fact, the systematic unfairness adopted by many scientific journal and magazines – including *Science, Nature,* and *Scientific American* – against non-naturalist scientists, such as, say, creationists or parapsychologists, is too well-known to need to be pointed out.

2117 See [Barz64] p. 9 et seqq. and [Mali87] p. 33 et seqq.

science increasingly has come to be viewed as an irrational, nihilistic power game both by its critics and by the scientists themselves.

5) *Lack of tolerance.* The compulsion of modern science to suppress research agendas predicated upon metaphysical presuppositions other than those of naturalism is revealing both as to the lack of real spiritual and ethical stamina of the naturalistic agenda and the ulterior, extrascientific motives behind today's science.[2118] Rather ironically, from the very democratic and pluralistic premises of present-day Western society so closely coupled to the cult of science it seems quite anomalous to let science – which mostly is funded by taxpayer's money – act as a bulwark for a single metaphysical standpoint – and, at that, one with presumably rather limited popularity amongst taxpayers and arguably corrosive effects on society and its morality. At best, naturalism is a metaphysical standpoint amongst others, and there is no reason for exclusively promoting naturalistic perspectives at the expense of research agendas based on other metaphysical presuppositions, which, on the contrary, seem to be the ones that presently need support and protection in order to survive and thrive.[2119] For an open pursuit of truth, such as science according to its own rhetoric should be, a commitment to a certain metaphysical dogma will in any case be highly problematical, if not just unacceptable.[2120] Thomas Kuhn's idea – often cited by those who want to stifle new or alternative views – that the presence of multiple paradigms in a branch of science reflects a more immature state of affairs than the adoption of a single paradigm indeed will be questionable, in particular if made into a canonical prescript, and it can as well be argued that monoparadigmatism rather is indicative of the impoverishing effects of dogmatic naturalist petrification and the "mob psychology" characteristic of the scientific-academic world.

6) *Association with the increasingly discredited modern project.* Naturalist technoscience is part and parcel of the regulating system of modernity, Latour's "modern constitution", garnering much of its legitimisation by bestowing upon humanity apparent material boons and scientific lore in profusion. As has increasingly dawned upon men over time so as to become a founding – explicit or tacit, accepted or contested, hailed or execrated – supposition of our age, the cost of the modern project and its attempt at a technical-political implementation of the Cockaigne of the tale-tellers, the utopia of the millenarian enthusiasts, and the proud claims and whimsical pipe-dreams of the Gnostic-Hermetic magi is, however, extraordinary in terms of, *inter alia,* the destruction of spiritual values, the nihilist breakdown of the ethical foundations of society, the ideologisation and superficialisation of human thought, discourse, and culture, the devastation of landscapes, townscapes, and domestic milieux, the global homogenisation of both the intellectual and physical environments of man, and the decline of art, literature, and music, to say nothing of the horrors of modern

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2118 In most branches of science, anyone who advocates non-naturalist – or otherwise unconventional – ideas will have to reckon with difficulties in having papers published, getting tenure, and obtaining funds for research projects, and often such researchers become the victims of gruesome personal persecutions and denigration campaigns (see footnote 1517 on p. 310 for references). Deplorably, the various popular, exceedingly scientolatric and pseudo-rationalistic "skeptic" and "humanist" mouthpieces of the agenda of scientistic naturalism have all since the late 70s been able to escalate the intolerance against their own real or perceived non-naturalist antagonists through their extreme rhetoric and unrestrained condescension and derision of anyone who does not share their own outlook.

2119 Notably, religious universities and research institutions – of which quite a few exist in the USA – may act as valuable havens for alternative metaphysical systems (see [Hesb94], [Mars97a], and [Mali87]). Additionally, private funding may also be instrumental in promoting alternative perspectives. For one thing, research in parapsychology has largely been funded by private donations (see [Hans01b] p. 178 et seqq.).

2120 Rather oddly, scientistic-naturalistic dogmatism and quasi-religious fervour largely seem to be moulded on Christian theological dogmatism and zeal. But notwithstanding that, *for the sake of saving souls,* the Christian Church and the Christian states often went to great lengths in times gone by in order to protect the Christian herd and the divine revelation against heterodox corruption and anti-Christian assaults, it seems entirely out of order for the votaries of irreligious naturalism and scientism to emulate their historical adversaries' attitudes of theological dogmatism and religious fervour, as naturalism implicitly or explicitly denies 1) that there are any souls to save in the first place, 2) that there is such a thing as salvation, and 3) that our beliefs is a matter of issue, since, from a naturalist point of view, spiritual values and virtues are illusory and we will all soon die anyway and that's simply it. To the Christian believer, the correct understanding of the dogma, which sums up the essentials of the salvific faith and derives from divine revelation, is of course worth protecting and defending by all means, whereas to the serious naturalist nothing is really worth protecting and defending at all, as such an act of protection or defence would imply a recognition of objective values absolutely at odds with the naturalist premises, except, perhaps, if undertaken by some arbitrary nihilistic whim or grimace.

warfare, environmental disasters, third-world pauperism, over-population, the ruthless elimination of the unwanted unborn, the suffering inflicted to sentient life by 'scientific' industrialised animal husbandry, and so on.[2121] Additionally, the 'benefits' and the 'knowledge' technoscientific modernity allegedly provides man with, when looked at more closely, seem to be, at best, doubtful and deeply ambiguous, often insidiously entrapping us in *prima facie* unexpected ways and affecting both the inner and outer quality of human existence for the worse. There is a pervasive element of arrogance, violence, presumption, shallowness, and willed rhetorical (self-)delusion – or, to use Voegelin's terminology, pneumopathology – both in the discourse of modernism, be it naturalist or not, and in its overall attitude towards reality, laying bare its roots in a gnostic rebellion against reality, the order of the cosmos, and, ultimately, the ardently denied divine ground. Worst of all, the mistakes of modernism, its destruction of the spiritual and ethical realm, and its truth-occluding discourse cannot be undone; mankind seems to have been trapped in an inescapable technoscientific *circulus vitiosus,* which as likely as not may end up in some kind of eschatological disaster or 'technocalypse'.

7) *Lack of legitimacy*. If I am right in arguing that science, at least in its presently common form, animated by anti-Christian scientistic naturalism, has been found wanting in truth, in depth, in credible ethical foundation, in the reasonability of its ways of operation, and in tolerance against non-naturalist outlooks and that it is further discredited by its close ties with the deeply problematic modern project, the conclusion seems to be irrecusable that naturalistic science, and with it plausibly also the modernity founded on it, *eo ipso* lacks legitimacy.[2122] Other arguments to support such a thesis can be adduced as well. Firstly, the study of the history of science has fatally undermined the foundational myths of science and recovered the, at least according to the appraisal implicit in the usual scientistic rhetoric, doubtful, not to say scurrilous roots of modern science and technology in the Gnostic-Hermetic occult sciences (magic, alchemy, and astrology), in millenarian and Rosicrucian utopianism, and in the distorted and immanentised debris of the Christian worldview it purports to challenge.[2123] Only during the 'Enlightenment' attempts to shatter the Christian foundation of Western society, did technoscience start to transmute from a Hermetic-occult project into a naturalistic one, as the legitimising myths of the progress of mankind and the battle between science and religion were put together and the kind of violent, superficially rationalistic and mordantly anti-religious rhetoric still popular with present-day positivists, skeptics, humanists, scientistic rationalists, etc. was forged into a formidable cudgel, fervently to be brandished against Christian piety. Secondly, if the tree is indeed known by his fruit, the lack of depth, integrity, and authenticity typical of the modern-scientistic project – or, as some, speaking by the card, would be prone to say, its monstrosity, lunacy, impoverishment, and wickedness – becomes particularly salient when the cultural and spiritual end-products of modernity are compared to the achievements of traditional societies

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[2121] See footnote 1621 on p. 335 for some references to the literature concerned with the evaluation of modernity.

[2122] By legitimacy, I here mean something like a rightful claim to serve as a foundation for the way we understand the world and lead our lives. On the famous Löwith-Blumenberg debate on "die Legitimität der Neuzeit" as pursued in [Löwi49] (cf. also the expanded German version [Löwi53]), and [Blum99b], see [McKn89] p. 16 et seqq. and [McKn91] p. 6 et seqq. Löwith argued that modernity, construed as the human attempt to move forward through "progress" towards a utopian state of innerworldly perfection is illegitimate, as i) man is not capable of controlling history and ii) modernity denies the Christian roots of the modern project, which in fact is a secularisation of Christian *Heilsgeschichte,* and thereby creates the false impression of its own rationality in contrast to the irrationality of the dark ages of religion and theology. Blumenberg attempted to undermine this conclusion by claiming that such characteristic traits of modernity as human self-assertion and technoscientific progressivism did not emerge out of defiance to or the distortion of Christian doctrines. Instead, the former, he maintained, was largely a corollary of the late medieval nominalists' "theologischer Absolutismus", which made the world look irrational and incomplete and in need of man's demiurgic improvement to become better adapted to human needs, whereas the arrival of the belief in progress is to be understood as the consequence of new technological inventions, such as the telescope. [McKn89] p. 16 et seqq. and [McKn91] p. 6 et seqq. show that the new picture of the Renaissance, the early modern epoch, and the "scientific revolution" emerging from the work of a large number of scholars, including Frances Yates and D. P. Walker, has essentially overturned Blumenberg's thesis – and, thus, his attempt at a defence of the legitimacy of modernity. For one thing, both modern self-assertion and the progressivism coming out of this new self-confidence have turned out to be closely related to the revival of Neoplatonism, Hermeticism, and the occult sciences and the peculiar gnostic-millenarian enthusiasm of what Frances Yates called the 'Rosicrucian Enlightenment'.

[2123] See p. 319 above.

founded on a vigorous and salutary spiritual life and vision, such as the medieval Catholicism so often horrendously maligned by the modernist polemicists.[2124] From the standpoint of such a traditional society, the era of modern science, technology, philosophy, and theology will appear as a bottomless pit, where science – *scientia,* knowledge and insight – has degenerated into disbelief in genuine knowledge and insight, where technology – the study of *techne,* art – has degenerated into a sacrilegious travesty of genuine art, where philosophy – love of *sophia,* wisdom – has degenerated into disbelief in all genuine wisdom, and where even theology – the study of *theos,* God – has degenerated into disbelief in or even blasphemous hatred of God. From this traditionalist point of view, we are indeed the most pitiable of all generations to live in such a poisoned climate of opinion that genuine science, art, wisdom, and even the love of God has become entirely occluded by the webs of deceit woven from the threads of specious arguments and superficial sophistry. From a Christian standpoint, modernity comes down to a bold Gnostic rebellion against Christianity and, thus ultimately, nothing less than a rebellion against and an assault on Christ Himself. But a human rebellion against the divine ground is hardly a project with auspicious prospects, but is bound to end up like earlier examples of such rebellions, such as the one instigated in the desert of Sinai by Korah – who in fact was one of the ancient Gnostics' celebrated 'heroes'.[2125] Only that the number of supporters of the modernist Korahs exceeds 250 by far.

If we accept the conclusions that the modern scientific worldview is *not* an approach to truth, but rather a gnostic departure from it, and that scientists, and especially élite scientists, will seldom be the sources of profound and all-encompassing wisdom they are so frequently held to be, but will more often than not be quite ignorant as to anything outside their own narrow range of special expertise and given to excessive naïveté and doctrinairism in theological, philosophical, and ethical matters, too often being – as exemplified by the belligerent positivist cadres of yore and today's no less bellicose neo-Darwinists or "skeptics" – intolerant and dogmatic materialist, nihilist, and atheist bigots with little interest in a really *open* quest for truth, one may ask what we are to make of science, that much-vaunted idol of modernity. Something that in spite of brave claims to the contrary is lacking in truth, that has brought mankind all kinds of heinous fruits from mass extinction weaponry to environmental catastrophes, overpopulation, and the devastation of the face of the Earth, and that in spite of its quasi-religious claims is unable to render unto man virtue, meaning, or spiritual, ethical, or aesthetical value and counsel, but rather through its implicit nihilism tends to nullify all the things that make life precious, will arguably be a candidate for serious questioning and distrust. In fact, such distrust has become such a natural and integral part of contemporary culture that no eyebrows will be raised even at the *per se* shocking conclusion made by an increasing number of observers that the canker of scientific-academic nihilism, having penetrated all parts of the body of Western society and culture – or perhaps rather of the body of an increasingly homogeneous global society –, now threatens to kill off not only all spiritual-religious life, but all life whatsoever through the various "limit performances" endeavoured by reckless scientomaniacs, a rapidly proliferating breed of Dr. Frankensteins, intoxicated by their own rhetoric and nihilistic pride.[2126]

For, if anything, naturalist science, scientism, and the scientific institutions are pervaded by boundless *pride,* the first and, according to many eminent theologians[2127], worst of the mortal sins. We started our historical exposé by pointing out that amongst the metahistorical patterns historians have believed to be able to descry in the events of history, the one promulgated in ancient times by Herodotus, "the father of history",

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[2124] In order to see this, one may only juxtapose the sublime beauty of the Gothic cathedral to the unsurpassed ugliness of the modern sky-scraper, the exalted serenity of the Gregorian chant to the diabolic din of modern music, the depth and stringency of the philosophies of the Fathers, St. Thomas, and St. Bonaventure to the disoriented ramblings and wanton assertions of Nietzsche, Lenin, Heidegger, Ayer, Sartre, and the other sophists presently laying an unwarranted claim to philosophy, the medieval saints' noble quest for communion with God to the modern scientists' and politicians' ignoble and presumptuous attempts to forget or abolish God and install themselves in His place, the tranquil bliss and heavenly tone that stream from the poetry and art of the Middle Ages to the nonsensical and debased junk that is called poetry and art these days, or the Catholic-Orthodox Fathers' and theologians' zeal for the truthful exposition of the Christian doctrine to the liberal theologians' struggle for the destruction of Christianity.

[2125] *Nu. 16*

[2126] So [Viri00]. On the spiritual destructivity of modern Academe, see also [Mali87], [Bloo87], [Smit91], and [Voeg66]. See also below p. 499.

[2127] For instance, this was the view of St. Thomas, who denounced pride as the source of all sins. See [Dela11]. Cf. also [Lind86a] p. 132 et seqq.

and Sophocles, the great tragedian, – and later to be secularised by Thucydides – will carry greater conviction than most latter-day historiosophical constructions.[2128] According to this scheme, too much success, being a sign of one's having yielded to temptation, arouses ***φθόνος θεῶν***, the envy of the gods, who, by instilling *hubris,* pride, however, prepare the utter downfall of the successful and proud. Anyone, who has attempted to look at the world through Herodotean spectacles, will attest to the fundamental truth inherent in this model of history, both at the macrohistorical and at the microhistorical level of interpretation. More closely to our own times, Spengler believed that religion and mysticism would in time conquer scientific rationalism and Sorokin hoped that the sensate culture would be followed by a new ideate era, although today these forecasts will admittedly look suspiciously like alienated Romantics' pipe dreams. But even though the *nemesis divina* sometimes will be quick enough, more often she is surely tardy in doing her work. Evidently, there is little to warrant a belief that the immense and ever-expanding power of science and technology will be broken in the foreseeable future. On the contrary, science has become a brute fact of man's world, just like weapons, nations, money, politicians, wars, and crime, and, as with these, it might well be that its downfall will not predate the end of this world. But although it may seem exceedingly naïve to believe that today's Faustian technoscience can be controlled and made less malevolent, it appears to be unwise in the extreme to just let it run its course and not attempt to reform its current aberrant ways in some way or other. After all, various control mechanisms and an abundance of reform proposals and attempts, though indeed often awkwardly inefficient, exist for weapons, nations, money, politicians, wars, and crime.

In any case, we are both entitled and obliged to ask: May there be a better science that does not deceive, but illumine us, that does not expedite, but postpone the end of mankind? In this study, it will not be possible to penetrate deeply into the staggering complex of issues that bear on these two questions, but instead we will have to content ourselves by throwing out a few suggestions about some problems worthy of consideration.

Firstly, the prevalent notion that scientists and engineers are atheistic machines without responsibility for the consequences of the theories and contraptions they have wrought (the neutrality myth) seems both dangerous and insipid; conscience and ethical afterthought, which, in our contention at least, only can be adequately grounded in a spiritual-religious outlook, should be virtues fostered amongst scientists no less than amongst other members of humanity. Additionally, some kind of external control mechanism is obviously called for in order to keep technoscientific destructiveness and impetuosity within at least some kind of bounds, although I am at a loss to understand what such an arrangement should look like and how any restrictions put on such an onager could ever become efficient. Still, the current political-military détente in the world, short-lived though it may be, may provide a certain opportunity for attempts at the disarmament also of technoscientific research.

Secondly, in order to foster a less destructive and belligerent, more reasonable and humble science, open to religious, spiritual, and ethical perspectives, the present rule in science of the naturalistic-scientistic anti-religion forged by the Enlightenment philosophers and their epigones must evidently be broken. To achieve such a therapeutic feat, it will be necessary to find adequate means of encouraging and protecting alternative scientific paradigms, which take religious, spiritual, and other non-naturalist viewpoints seriously. The need for alternatives and pluralism will be particularly conspicuous within areas such as biology, "the brain sciences", medicine, and cosmology, where the monoparadigmatic lopsidedness seems to have petrified into the most entrenched dogmatism and deplorable contempt for those who do not share in the ruling naturalist code of belief. For one thing, instead of the still rampant positivistic anti-metaphysicalism, being in essence but a veil for naturalism, an awareness of the significance of metaphysical presuppositions and an enhanced sensibility as to the value of entertaining multiple paradigms will, I submit, need to be cultivated.

If alternative, theistic and syncretistic points of view shall be able to prosper, adequate measures against the current more or less monolithic predominance of atheistic-nihilistic agendas, both within the sciences and the humanities, will obviously have to be taken, although the proper steps will by no means be easy to find, will *per se* only provide the first preliminaries to the endeavour of regaining the sanity of Western culture, and are certain to evoke the fury of the truculent legions of die-hard nihilists, who would fain hurl mankind together with themselves over the edge of the Gadarene cliff rather than give leeway to anything but their own gloomy ways of thought and life. In order to get the labour at a cure for the contemporary nihilist malaise of Academe going, both political intervention and some kind of religious "revival" amongst the well-educated

[2128] See above p. 352.

will certainly be needed. The rules of science must be revised so as to ensure pluralism rather than monism and create havens for research performed under alternative metaphysical presuppositions.

First and foremost, the denial of transcendence must be done away with and the rediscovery of the spiritual dimensions of reality ensured. In particular, the mountain of untruth amassed by Darwinist biologists, whose pernicious miasma, cloaked as infallible "science", has poisoned our entire civilisation and now threatens to drive away what is still left of goodness, hope, and civility from the pre-modern, Christian era, must be exploded. The 19th century nihilistic conquest of the then still largely Christian, or at least vaguely religious, Academe was largely the work of the scheming and plotting of Thomas Huxley, who, from the position he had arrogated to himself in British science, pursued a kind of nihilistic *jihad,* by all means trying to promote his own Darwinist comrades-in-arms to key positions in British Academe and to oust those who did not share his own vehement anti-Christianism, thereby paving the way for the present ideological hegemony of Darwinism in the life sciences – a policy which, soon spreading all over the globe, proved so successful that today any biologist who ventures to question Darwinism is likely to succumb in the disgraceful academic "struggle for survival".[2129] As Darwinism is the mainstay of present-day scientific materialism and nihilism, the current nihilist tyranny in Academe will never be broken unless alternative agendas of natural philosophy and biology, such as "intelligent design", old-Earth and young-Earth creationism, and the various strains of thought that build on the legacy of Aristotelianism, Scholasticism, and Romantic *Naturphilosophie,* are re-invigorated and given the very material support necessary to survive, develop, and, hopefully, prosper in the face of the malicious attacks and ruses of the votaries of the Darwinist juggernaut. Probably, separate academic chairs and departments, research institutes, journals, conferences, courses, etc. must be established for these alternative research agendas, wholly outside the control of the doctrinaire Darwinist establishment, if such an attempt shall be successful.

Granted that today's Academe is the stronghold of modernism – including ultramodern postmodernism – , are not the prospects of any attempt to overturn the current rule of modernist materialism and nihilism inauspicious, to say the least? For instance, Charles Malik in his thought-provoking book *A Christian Critique of the University,* admits that he cannot see how today's secular universities could ever possibly be restored to their Christian origins, although he nonetheless suggests the need for a Christian institute concerned with the critical assessment of and re-introduction of Christianity into Academe.[2130] Certainly, a few Christian universities exist, in particular in the United States, but they remain isolated havens for the faithful and, not scoring particularly high on the academic ranking list, will not be able to attract large groups of outsiders, let alone imperil the general hegemony of scientific materialism, nihilism, and relativism in Academe and society at large. In addition, the faculty of these Christian academies tends to get increasingly secularised and "liberal" over time, as a consequence of the general secularism of both society and Academe.

On the other hand, an appeal both to the Socratic-Platonic philosophic ideal of the academic quest as an *open* pursuit of *truth and wisdom* – as against the Baconian-Cartesian-Comtist anti-philosophic and anti-metaphysical ideal of a scientistic, power-fixated, exclusively or predominantly utilitarian technoscience – and to such founding ideas of the modern project itself as tolerance, pluralism, and "democratic rights" may, I suggest, prove a viable tactics for those of us who want to re-open also the non-confessional universities to theistic and syncretistic viewpoints. But such an appeal will also imply that the adherents of deeply opposed standpoints will have to strike a kind of strategic alliance, that, for example, Christian theists will have to accept that opportunities are given to other alternative agendas, such as the to many Christians odious phenomenon of "New Age science", or that non-Darwinist evolutionists, many of whom will be positively inclined to "New Age" ideas, will have to reach an *entente cordiale* with their old evolution-sceptical archenemies, such as most notably the Christian creationists.[2131] Such an alliance attained, it seems that the

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2129 See [Desm97].

2130 [Mali87]

2131 Works that may give an inkling of what "New Age science" is all about are [Lori99], [Harm91], [Harm94], [Thom81], and [Wilb98]. Some minor academic subdisciplines, such as transpersonal and analytical psychology, are already dominated by "New Age" and kindred ideas. An acerbic evangelical-Christian critique of some varieties of New Age science is provided in [AW96] p. 499 et seqq. et passim. A large number of such Christian critiques of the New Age ideas in general are surveyed and evaluated – from a rather ultraliberal theological vantage point – in [Sali99b]. Although much "New Age science" will appear odd, naïve, or, to many Christians at least, ethically or theologically reprehensible due to its association with pantheism, occultism, and non-Christian religions and the "New Age" is the direct descendant of the very ancient Gnosticism and Renaissance occultism, from which the nihilistic-scientistic outlook and biological evolutionism emerged in the first place, the New Age insistence on the importance of spiritual experience and paranormal phenomena may at

programme of pluralisation and detotalitarianisation of science should be able to gain considerable popular and political support, if the case for it is argued with prudence and force by all parties opposed to the current materialist-nihilist absolutism.[2132] After all, a society celebrating "the rights of man" as its foundation cannot in the long run deny the right to free speech and thought also within Academe, its own most respected and authoritative institution, without fatally undermining its own credibility. And the glaring impropriety of the tyrannic rule in Academe of such a blatantly quasi-religious and anti-Christian agenda as neo-Darwinism is too conspicuous to be condoned forever by those who pay the piper *if only* the cards are put on the table, clearly visible for them to see.[2133] In particular, the growing insight that today's technoscience is about to wreak havoc with the planet will make both politicians and people in general ready to consider alternative agendas. There is also in the heart of man a longing for the divine and true spiritual food that not even the diabolic efficiency of three centuries of atheistic and scientistic propaganda and the mass indulgence in all kinds of superficial substitutes for the life of the spirit have been able to extinguish. In fact, the very name "Academe" seems rather ludicrous when equated with the kind of Sophistic derailments – materialism, atheism, nihilism, etc. – against which the founder of the original Academy was fervently and unyieldingly militating during his entire life.

So, provided that the rule of today's academic materialism and nihilism were shattered by some felicitous or miraculous contingency and, contrary to all expectations, a more multiparadigmatic, open climate of opinion was established in science, to what agenda would then the present author attach his hopes and give his cheers? In his captivating study *Orthodoxy,* G. K. Chesterton recounts how he was driven to orthodox, Catholic Christianity by reading and listening to atheists, agnostics, evolutionists, rationalists, sceptics, free-thinkers, theosophists, and their likes –"Huxley and Herbert Spencer and Bradlaugh"–, becoming increasingly put off by the absurdity, inconsistency, and morbidity of their arguments and finally arriving at the conclusion:[2134]

> *Perhaps, after all, it is Christianity that is sane and all its critics that are mad–in various ways.*[2135]

The present author must confess that the writings of the present-day modernists and postmodernists; political radicals, Marxians, feminists, and other ideologists; neo-pagans, neo-Gnostics, Freudians, and Jungians; scientistic positivists, rationalists, secular humanists, and neo-Darwinists, to say nothing of the skeptics of the *CSICOP* ilk, produce a very similar effect in him. Also the fanaticism, in which many scientists and scholars committed to this or that anti-Christian agenda tend to indulge, as though they suffered from some impish affliction, adds to this conclusion.[2136] Strong emotions and vehement actions may be warranted if one really has something worth protecting, as, for instance, the Christian theologians, apologists, heresiologists, and even the crusaders and inquisitors not unreasonably felt they had, although we may indeed at times find fault with the imperfect way they brought their convictions to bear on their contemporaries. However, it is difficult to see the rationale behind either the passionate enthusiasm for their own hollow agendas or the acrimonious bitterness against the Christian religion and God amongst the modern apostates from Christianity. It is as though they tried to emulate the Christian zeal for the gospel and the salvation of mankind, although they themselves deny the very possibility of any salvific actions at all and have only the most vacuous, lifeless and sad vision of the universe, man, and science, a gospel of hopelessness, meaninglessness, and universal scepticism and nihilism, to put in the place of the Christian hope, thus, ending up as paradoxical missionaries and zealots for nothingness. So, one cannot but get the impression that their violent incantations flow from some kind of deep-seated, pathologic or even demonic hatred or fear of life, man, and

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least help to wobble the currently predominant "scientific materialism" and, thus, be apt to bring people to reflect on God, the life of the spirit, world-views, and metaphysics, thereby creating an opportunity also for Christian missionary activity.

2132 Paul Feyerabend will be the most famous advocate of such scientific multi-paradigmatism. See [Feye93].

2133 Cf. [Zogb01].

2134 [Ches1908] p. 136 et seqq.

2135 Id. op. p. 149.

2136 See footnote 1517 on p. 310 and footnote 1580 on p. 324.

the cosmos itself, a cheerless rebellion against God, existence, and reality, in short the attitude, which was so aptly called 'gnostic' by Voegelin.[2137]

Whereas naturalistic-scientistic modernism, for all its current influence and power, seems to be but a pneumopathologic gnostic cult of unreason and much 'New Age' syncretism, albeit more reasonable and open in its basic approach to reality, often appears to be lacking in critical attitude, spiritual discernment, and authenticity, classical, orthodox "mere Christianity"[2138], I submit, has a lot to speak for it, striking a sensible balance, the plausible *aurea mediocritas,* between the implausible extreme views taken by these other agendas. For example, the common sense, reasonability, and spiritual discernment of Christian orthodoxy show in its support for:

1) a conception of the world as created and, thus, real, designed, and ordered (vs. the implausible views of it as either non-existent or as self-existent and inexplicably self-organising)
2) a realist epistemology (vs. Kantian, positivist, and postmodern constructivism and subjectivism, Humean scepticism, scientistic physicalism, and other kindred doctrines that implausibly proclaim that our experienced reality is not to be considered real at all, but that we are all living in some kind of dream-world or illusion)
3) a non-monist metaphysics and cosmology (vs. the implausibilities of apsychist materialism and acosmist idealism)
4) a non-monist anthropology (vs. all the absurd varieties of neuromonism, according to which we, contrary to all evidence, are but zombies, "meat machines", or computers and our psychic life non-existent or epiphenomenal)
5) the affirmation of a 'personal', loving God (vs. the sombre conception of the universe as an intrinsically meaningless process, be it conceived as aleatory or deterministic, or the paranoid gnostic notion of it as created and ruled by powers of evil)
6) a sceptical stance towards claims of man's divinity, perfection, and intrinsic goodness (vs. a blatantly counterfactual New Age or other optimism as to man's moral standing and the self-defeating excesses and corruption that tend to accompany such optimism)
7) the view that the evil of this world, the sad fact "that the whole creation groaneth and travaileth in pain together", is the result of a fatal event, a fall, and the consequential contraction of a divine curse, for which man is, through the abuse of his free will, himself ultimately guilty (vs. the view that the Ground of the universe is corrupt, perverted, indifferent, callous, or non-existent and man perfect and free from blame)[2139]

[2137] Cf. [Slou95] p. 104 et seqq.

[2138] [Lewi96d]. [Arle96] provides an erudite account and a sagacious assessment of modern occultism, as compared to traditional Christian belief.

[2139] The doctrine of the fall of man and man's guilt and sinfulness, especially as expounded by St. Augustine, is often accused of being unduly pessimistic. But this alleged "pessimism" – together with the recognition of the free will of man – paves the way for a much more profound Christian optimism as to the goodness and perfection of the Ground of being, for if the fall of man – which, besides, is not a specific Jewish-Christian doctrine, but a belief prevalent all over the world (see footnote 1675 on p. 348) – is denied, then the cause of all the evils of the world must be within the Ground of being itself. Thus, an "optimistic" belief in the goodness and divinity of man by necessity implies a much more lugubrious cosmic pessimism. In fact, this simple, rather self-evident anti-gnostic logic of being is amply corroborated both by the current plight of the world and man's daily experience.

It should be noted that the patristic Christian doctrine of ***θ□οσις***, *divinization,* especially, but not exclusively cherished in the Eastern Orthodox Church, is not, as sometimes claimed, some kind of celebration of man's divine perfection and freedom from guilt, setting a life-assenting Eastern theology apart from its life-denying, Augustinian-Manichaean Western counterpart. On the contrary, this doctrine establishes how man, having gone through a process of sanctification and spiritual struggles and exercises, can already in this life, by God's grace, experience the *visio beatifica,* which, if the distinction made in Eastern Orthodox theology is accepted, can be said to imply an intimate 'participation' in or 'union' with God's uncreated, immanent *energies,* through which God makes Himself known unto man, but not with His transcendent and to man inaccessible *essence.* But this 'union' between man and God, which is supposed to happen only in the next life for those believers who are not saints or mystics, is not to be interpreted pantheistically, as man and God remain separate in it, and does by no means make the man who receives this special grace infallible or perfect. As seen from the lives of the great saints, the mystical path is rather characterised by self-oblivion, great personal tribulations and sufferings, and unending struggles against man's sinful nature and the temptations that beset man in quest for God, entirely at odds with the rose gardens of the anthropocentric humanist life worshippers and the temples of spiritual pride built by the self-proclaimed *perfecti* of present-day self-salving enthusiasm. On the con-

8) the good news of the Christian gospel that this fatal event not only can, but actually is about to be undone by the redeeming work of Christ (vs. the fatalism, hollowness, and hopelessness of postmodern nihilism, gnostic pessimism, scientism, skepticism, modern progressivism towards the abyss, and suchlike)

9) the view that man survives death and will reap in the other world the fruits of his deeds in this world (vs. the modern and postmodern celebration of annihilation and meaninglessness and the concomitant antinomianism and moral nihilism)

10) the acceptance of a spiritual realm, but scepticism towards the wisdom of trafficking with its forces without great discernment and ecclesiastical supervision (vs. both the irrationality of the flat 'skeptical' denial of the overwhelming evidence for paranormal and mystical phenomena and the credulity and absurdity that tend to go with occultism, spiritism, neo-paganism, gnosticism, and other forms of undiscerning dabbling in attempted contacts with the demonic-spiritual realm)

11) man's responsibility to reform his heart, make use of his conscience, and serve his fellowmen in love and sincerity (vs. hypocrisy, pharisaism, gnostic *anomie,* and modern moral nihilism with its concomitant religions of arbitrary hatred – be they of the nationalist, Nazi, Marxian, or some other flavour – and its undiscerning progressivist technoduly, as instituted by the "Cartesian divide" and the "modern constitution").

The above roster is not an attempt to provide an apology for Christianity, a pursuit that falls outside the purpose of the present study, but is intended to lend support to the view that the Christian religion, which *de facto* is the basis of our civilisation, also provides a pre-eminently reasonable basis for intellectual pursuits and, on the whole, a much more credible and, in the true sense of the word, rational worldview than the presently popular modernist, postmodernist, and syncretist belief systems. In spite of this reasonability of the Christian outlook, Christians – or "fundamentalists" as orthodox Christians are often denounced these days – have presently become a major *bête noire* in Academe, just like the Jews, "the bourgeoisie", "the capitalists", and various other groups were detested and ridiculed in this pre-eminently gnostic milieu at earlier points of time. In some academic circles, it even seems that the slightest suspicion of Christian sympathies will be enough to count severely against a researcher.[2140] Today, scholarly books and publications are often seasoned with the most ridiculous sideswipes and imbecilities about the Christian faith "as if any stick was good enough to beat Christianity with".[2141] Worse still, excellent scientists and scholars framing their views from a Christian outlook, such as the advocates of the school of *intelligent design,* are often either ignored or met with incredulity by their colleagues, if they are not openly persecuted as the prime enemies of science and society.[2142]

But what then would a Christian vision for the University and scientific research look like?[2143] I have already suggested that an alternative paradigm of *biology* will be a key component of such a vision, that the

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cept of *divinization,* see [Will99], [Nell87], [Wäre93] p. 155 et seqq.; on the distinction between God's *essence* and *energies,* which is unique to Eastern orthodoxy and, for example, not accepted in Scholastic and Roman-Catholic theology, where the absolute unity of God and the impossibility of making a distinction between His essence and attributes are asserted, see [Will99] p. 137 et seqq., [Wäre93] p. 26 et seqq., and [Fort10]. Cf. also [Poul1908] and [McEv82] p. 241 et seqq.

2140 Cf. [Berg84] and [LW99b].

2141 [Ches1908] p. 145. Just to mention a single, but quite typical example of such silly Christianity-bashing, the well-known and erudite scholar Norman Cohn in his (very biased) study of apocalypticism [Cohn93] brands Christianity "the Jesus sect". Should we, then, call Cohn a member of "the Moses sect"? And are we supposed to call Islam "the Mohammed sect" and Buddhism "the Buddha sect"?

2142 See [John95a].

2143 Some works containing suggestions about such an agenda are [Hesb94], [Mars97a], and [Mali87]. Web sites offering other relevant material are http://www.clm.org, http://www.leaderu.com, and http://www.discovery.org/crsc. The home page of the *Science and Theology Web Ring* at http://www.cus.cam.ac.uk/~nts1001/ringhome.html lists more web resources concerned with science and Christian faith. Cf. also [Lewi96a] p. 83, where C. S. Lewis, having criticised modern science for its basically magical-instrumental, deeply amoral obsession with power over nature *at any cost* and the educational 'conditioners', who, having abandoned the *Tao,* i.e. the traditional morality common to all peoples and religions, blithely embrace the poisonous and utterly demoralising scientific-rationalistic attitudes, for their attempts to create an artificial morality based on the evanescent foundation of their own nihilism and to inculcate this monstrosity on the younger generations, makes this proposal for a better kind of science:

"Is it, then, possible to imagine a new Natural Philosophy, continually conscious that the "natural object" produced by analysis and abstraction is not reality but only a view, and always correcting the abstraction? I hardly know what I am asking for. I hear rumours that Goethe's approach to nature deserves fuller consideration – that even Dr. Steiner may have seen something that orthodox researchers

current preponderance of neo-Darwinism in biology *must* be broken, teleology re-introduced, and adequate means provided for other biological research programmes to prosper, such as "intelligent design", old-Earth and young-Earth creationism, and the Aristotelian-Scholastic biological tradition. But evidently, an isolated camisado against evolutionary biology will not be able to dispel academic nihilism, but needs to be backed up by attacks on all fronts of research and scholarship in order to become successful. A few areas should be given particular consideration.

Firstly, *theology* must be reinvigorated and restored from its current position as the whipping-boy of Academe and the obsequious admirer and imitator of secularist research to its former pride of place as the queen of the sciences and the plier of *Erlösungswissen,* the highest form of knowledge there is and certainly widely superior to the shallow *Leistungswissen* of science, as without a vigorous and sound theological foundation there can, I contend, be no hope for a cure of the current nihilist malaise in Academe, the sciences, the humanities, and, in the end, our entire society and culture. For one thing, only theology can provide us with a sound basis for making judgements about the ethicality of research and technological developments. Today, theological faculties and seminaries have however, particularly in the Protestant world, largely succumbed to the onslaught of modernism and are often dominated by different kinds of nihilists – "liberal theologians", religious and moral relativists, agnostics, atheists, etc. –, not seldom of the most relentless hue. By insidiously wearing down the faith of the young people there still are, who, in spite of the persistent anti-religious propaganda and indoctrination that have met them through the mass media and modern education since their early childhood, want to give themselves to the service of God, by inundating them with cheap nihilistic sophisms and pseudorational arguments, and by forcing upon them one-sided "liberal", agnostic, or openly anti-Christian literature before their faith has gained the maturity and strength that can see through all this massive nihilistic blather, these academic grave-diggers of Christianity have given us a clergy riddled with hypocrisy and heresy, dogmatic disorientation, personal doubts, sentiments of being out of joint with their own times and in need of catching up, and, apparently often lacking robust faith, piety, and devotion itself, also being unable to inspire these virtues in others.

This dissolution of the Christian faith will be the ultimate corollary of the breakdown of the Christian principle of authority, founded in the grateful acquiescence in divine revelation and the tradition of the Church, brought about by the rebelliousness of the Protestant Reformers, who by replacing the principle of the authority of the Church by the principle of their own right to reform the Christian religion according to their own perceptions and caprices as to what it should be like, usually underpinned by little more than vehement rhetoric, "the magic of the extreme" later to be so rapaciously emulated by the proponents of atheism, materialism, rationalism, and nihilism, sundered Christianity into a turmoil of warring sects. But we have already considered the unhappy consequences and self-defeating character of the Reformers' arbitrary curtailment of the Christian faith at some length and need not repeat this line of reasoning here. As soon as their principle of sectarian free-thought, limiting the rights to reformulate the faith to the founder of the sect – Luther, Calvin, Zwingli, Sozzini, Fox, etc. –, was extended into a principle of general free-thought, the unbounded theological-philosophical chaos characteristic of today's Protestantism necessarily supervened. But a theology, which itself ends up in all kinds of nihilist atheologies, blasphemies, and heinous heresies, will never be able to provide the countervailing force against nihilism and relativism we are looking for here, but has, it appears, done away with its own *raison d'être:* "If the salt have lost his savour, wherewith shall it be salted? It is thenceforth good for nothing, but to be cast out, and to be trodden under foot of men."[2144] Thus, the theological faculties must somehow be restored to orthodox Christianity, if they are to be of any use and if the *bona*

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have missed. The regenerate science which I have in mind would not do even to minerals and vegetables what modern science threatens to do man himself. When it explained it would not explain away. When it spoke of the parts it would remember the whole. While studying the *It* it would not lose what Martin Buber calls the *Thou*-situation. The analogy between the *Tao* of Man and the instincts of an animal species would mean for it new light cast on the unknown thing, Instinct, by the inly known reality of conscience and not a reduction of conscience to the category of Instinct. Its followers would not be free with the words *only* and *merely*. In a word, it would conquer Nature without being at the same time conquered by her and buy knowledge at a lower cost than that of life."

He concludes his treatise thus (p. 86 et seq.): "But you cannot go on "explaining away" for ever: you will find that you have explained explanation itself away. You cannot go on "seeing through" things for ever. The whole point of seeing through something is to see something through it. It is good that the window should be transparent, because the street or garden beyond it is opaque. How if you saw through the garden too? It is no use trying to "see through" first principles. If you see through everything, then everything is transparent. But a wholly transparent world is an invisible world. To "see through" all things is the same as not to see." Cf. also [Fort95], who argues for a re-introduction of final causes in science in order to overcome the ills created by the Baconian-Cartesian paradigm.

2144 *Ev. Matt. 5:13*

fide Christian faith is not to be wholly extinguished in the West. How this admittedly demanding project is to be brought underway, however, falls outside the scope of the current study.[2145]

Secondly, another task of paramount importance, if we are to regain sanity in the Western world, a task closely related to the restoration of theology, will be the regeneration of Christian *philosophy* and *metaphysics,* i.e. Scheler's *Wesenswissen.* Thus, the current preponderance of different varieties of Poortman's *Alpha* standpoint – positivistic anti-metaphysics, materialism, cognitivism, nihilism, postmodernism, existentialism, etc. – within academic philosophy must somehow be staunched and exorcised. Rather than concerning themselves with such "philosophisms", true philosophers should always bear in mind the commitment to *wisdom* implied by the name of their trade and strive to underpin rather than undermine wisdom, devoting themselves to a serious and humble quest for the truth in preference to the futile madness of the secularists' voguish egophanic show-pieces, which may well attest to their authors' intellectual prowess, but will not bring mankind an inch closer to the truth about being. For one thing, philosophy should take the unavoidability of metaphysical presuppositions seriously and demonstrate their significance and implications in scientific enterprises in order to help us understand the pros and cons of the different alternatives at hand.

Thirdly, the vindication of the experiential basis of religion, the life of the spirit, will be of prime importance if we are ever to overcome materialism and nihilism, since if we do not grant that we can experience God and the spiritual realm, they are destined to degenerate into logical inferences, which sooner or later will fade away altogether, as demonstrated by the failure of all attempts to create a deistic-rationalistic religion. Thus, the study of *mysticism*, that is to say the realm most palpably concerned with man's experiential encounter with the divine and transcendental, and the theological interpretation and discerning evaluation of mystical experiences and phenomena through *mystical theology* will be key to the attempted cure of the materialistic-nihilistic malaise – provided that the present prominence in this area of drug prophets and atheistic or skeptic despisers of religion can be quelled. In particular, all students of theology should as a matter of course be initiated into the life of the spirit, if they shall be able to serve as the spiritual directors of others, becoming privy not only to the Scriptural and dogmatic treasures of the Church, but also to "the living water" of its spiritual and mystical traditions and, most importantly, to the difficult art of spiritual discernment.

Fourthly, *parapsychology,* being the study of the phenomena, which arguably demonstrate the vacuity of scientific materialism most strikingly, must be given its proper place in Academe and should be protected from invasion by "skeptics", who already have caused much damage to the unbiased study of the paranormal phenomena.[2146] Parapsychology should also be open to, encourage, and take advantage of religious and theological vantage points and interpretations, which will not only considerably enrich, but, I opine, provide a much better overall theoretical understanding of these phenomena than the rather contrived and artificial explanatory models currently favoured in the parapsychological community. For one thing, there exists in the

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[2145] Obviously, this cannot happen unless the theological faculties are brought back under orthodox ecclesiastical supervision so as to ensure their loyalty to the Christian Church and dogma. As Protestantism, at least in its European form, now seems to have run its course to the bitter end, which turned out to be nihilism, relativism, and secularism, the only force that plausibly can provide the source of the needed rebirth of academic theology will be the Roman Catholic Church, which – in its orthodox form, untainted by liberal theology and the sad moral decrepitude that, as has been demonstrated lately, tends to go with it – also happens to be the only Church that credibly can make the claim of representing a continuous, authoritative, undiluted, and timeless theological tradition that goes back to the foundation of the Christian Church. Although it may *prima facie* seem that the Eastern Orthodox Church also would be able to make such a claim – and this Church admittedly embodies a tradition of great theological, spiritual, and ethical value –, its self-inflicted break with Rome closely parallels the Protestant one, insofar as it derived from blatant acts of ecclesiastical insubordination and insurrection fomented by the self-interest of Machiavellian sovereigns. Just as the Reformers were used by the powers that be to sanction their greed and marital irregularities (see [Nyma97] for a good Catholic account of the disastrous spiritual and cultural consequences of the Reformation in Sweden, the first country to carry out the Reformation), the Orthodox Luther, the power-hungry, truculent, and erudite Byzantine Secretary of State Photius was – contrary to all canon law and ecclesiastic custom – made patriarch of Constantinople by the incestuous caesar Bardas, after he had deposed the lawful patriarch Ignatius because of his opposition to Bardas' vicious way of life (see [Fort11] for a concise statement of the Roman Catholic view of this schism). Still today, many of the leading Orthodox theologians, seemingly taking their cue from the relentless anti-Roman polemics introduced by Photius, before whom the authority and primacy of the Roman Pontiff as the successor of St. Peter and the visible head of the Church, being traceable back to the earliest times of the Church, were unanimously acknowledged amongst orthodox Christians, seem to be infected by a spirit of belligerent free-thought, theological arbitrariness, and linguistic vehemence reminiscent of that of the Reformers. In particular, these traits meet the eye in the current anti-ecumenical crusade endeavoured by some Orthodox theologians, who, apparently being much concerned with dubious traditionalist, nationalist, and ethnic considerations, boldly choose to neglect the compelling necessity for all Christians to take seriously Christ's bestowal of ecclesiastic authority upon St. Peter *(Ev. Matt 16:18, Ev. Jo. 21)* and His prayers as to the unity of His Church *(Ev. Jo. 17:21).*

[2146] See, for example, [Ingl86].

Catholic Church a long tradition of critical assessment of miracles and other paranormal phenomena, going back to the early days of the Church – featuring highly interesting research performed by such first-rate thinkers as St. Augustine, St. Gregory the Great, and Benedict XIV –, having amassed through the beatification and canonisation processes of the saints a formidable treasure of often excellently documented and attested, highly striking paranormal phenomena.[2147] Although paraphobia has often predominated in the Protestant world, already the Cambridge Platonists saw the need for the study of the paranormal "as an antidote against atheism", and since then more and more Protestants have come to realise the absurdity of the Reformers' contention that the time of miracles ended in the early days of the Church and the damaging consequences of this idea to the credibility of the Christian faith.[2148] Although the risk of parapsychology being used to endorse occult, to Christians illicit, practices should by no means be underrated, a genuine, penetrating and critical understanding of the paranormal will nonetheless be essential in order to steer clear of the perils connected with the occult, assess all kinds of claims derived from paranormal phenomena with discernment, arrive at a realistic worldview that includes also the spiritual dimension of reality, and credibly underpin a non-naturalist metaphysics.

Fifthly, although the study of *history* has been the great liberator from the nightmare of positivistic progressivism by revealing the true sources of modernity and the inanity of the rampant propagandistic constructs, historiography is still haunted by the legacy of anti-Christian bias and mythmaking. For one thing, a lack of proper understanding of the paranormal will lead to very bad criteria in sifting out historical fact from mythical fiction. Macrohistory is evidently an area fraught with pitfalls and perils, but is nevertheless of key importance for our interpretation of ourselves and our own rôle and destiny in the world and, thus, inevitably of crucial religious-ethical importance. For one thing, the entire modern project together with its faith in technoscience is predicated on the premise of the Enlightenment myth of progress. Christian macrohistory will need to avoid both the secular Charybdis of disregarding spiritual driving forces altogether and the enthusiast Scylla of freewheeling apocalyptic-eschatological speculation. We cannot here go into the other disciplines of the humanities, for all of which the ramifications of a Christian perspective need to be worked out.

Sixthly, as for the *sciences* proper and *technology,* i.e. what Scheler and Latour refer to as *Leistungswissen* and *technoscience* respectively, the Christian point of view will be particularly concerned with three issues, viz. the theological-philosophical evaluation and criticism of

- the integrity of the metaphysical presuppositions that regulate scientific research
- the credibility and theological-philosophical ramifications of the scientific claims, results, and theories[2149]
- the ethicality of the various research programmes and technological 'advances'

As for the two first issues, well-educated and intelligent Christian scientists and scholars are sorely needed both to show the incompleteness of scientific knowledge in general and to demonstrate the vacuity of the rampant pseudoscientific speculations set forth as irrefragable scientific fact by various secularist scientists, propagandists, and entire scientific coteries, often with the all too obvious sole intention of giving Christianity or religion in general a jab.

As to the third issue, I have argued in the preceding sections that the Cartesian divide, i.e. the mechanism protecting science from ethical scrutiny, will be absolutely at odds with the very essence of Christian faith, according to which ethics, being 'the laws of God' grounded in the divine Logos, is by no means something subjective, but as objective, nay more objective than any claimed scientific 'facts' or purported 'laws of nature'. But to apply this objective Christian ethics to technoscience does not only mean that Christians are to object to the obviously preposterous derailments of the technoscientific mentality, such as, say, the construction of diabolic weaponry or death camps, the Nazi doctors' hideous experiments on humans and other cruelty towards sentient beings motivated by the demands of scientific progress or industrial-technological efficiency,

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[2147] See footnote 1532 on p. 315.

[2148] See, for example, [Swin70], [Larm96], and [GH97b]. Cf. also [Mull96] on the history of this trend. On the dangers of occult practices from a pastoral perspective, see [Koch_a]. Cf. also [Raup20], [Wick], and [Hans01b] p. 162 et seqq. et passim.

[2149] We have already dealt with this issue as far as such overtly speculative, historiosophical disciplines as evolutionary biology and geochronology are concerned.

the slaughter of the innocent unborn in the name of women's rights and the subsequent use of their earthly remains for making medicaments, and similar abominations, but rather that all research must be submitted to a scrupulous and probing Christian ethical consequence analysis, "in fear and trembling"[2150] of the Lord. As such an analysis, if undertaken seriously, with unswerving candour and sufficient depth, is bound to reveal the great hazards that attach to virtually all technoscientific activity, since scientific knowledge actually *is* power and thus almost always potentially harmful, the rigorous application of the Christian perspective will by necessity bring science and technology to more or less a standstill – the much-ridiculed "Middle Ages" of the anti-Christian controversialists. As this is highly unlikely to ever happen in a world shaped by "the modern constitution" so as to abide by the Darwinian, fundamentally anti-Christian principles of "the struggle for existence" and "the survival of the fittest" – of states, companies, research institutions, scientists, etc. – and the scientific community seldom cares about Christianity anyway, the prime task of the Christian in science will plausibly be to enact the rôle of the tragic warner, to caution the scientists about the sinfulness and dangerousness of their pursuits and one-sided scientism, and to remind them that scientific curiosity is not a virtue, but a vice and that science has not brought mankind closer either to real truth or to true happiness, but away from them both. In the context of computing, I will come back to some of these ethical issues in more detail in the concluding sections of this study.[2151]

This said, Christians are no anarchists or primitivists and the Christian criticism of quasi-religious scientism and the modern project does not imply that Christians believe that civilisation can be given up or that Paradise can be established on earth. Thus, apart from their unpopular rôle as the debunkers of scientism and the Cassandras of modernity, there are some more positive tasks Christians could engage in within science and Academe. For one thing, there are innumerable adverse effects of the reckless ways of the technoscientific juggernaut that need to be mollified, including the aesthetical, ethical, and environmental destruction of man's *Lebenswelt* through the gnostic-scientific anti-ethics and anti-aesthetics of modernity.[2152] Making the world a little less polluted, cruel, ugly, and oblivious of God by trying to restore to technical design and architecture the sense for the ethical and aesthetical ideals – the true, the just, and the beautiful – and imperatives grounded in Christ, the divine Logos, is indeed a both worthy and formidable positive task. Secondly, the education of the young is an all-important and awe-inspiring responsibility, giving the Christian academic an opportunity to infuse, to the best of his ability, into the anti-Christian empire of darkness some Christian hope and love. Indeed, to work for Christ inside this empire will be a most delicate task, which demands Christians "wise as serpents, and harmless as doves"[2153], having "put on the whole armour of God".[2154]

In sum, I think that a plea should be made for humbleness and metaphysical openness in science against the current hubris, arrogance, and megalomania of naturalism, scientism, and lingering positivism as well as the flaunting nihilism of postmodernism, a plea for science as an *ancilla philosophiae et theologiae* – and occasionally as a means for *Existenzerhellung* – rather than as a Baconian power machinery subservient to morally doubtful state and other interests, a Dennetian acid of traditional religious and moral beliefs, or an Heideggerian *Ge-stell,* satanically entrapping mankind in a one-dimensional, wholly despiritualised snare of manipulative machinery, from which only a god can save us, in short, a plea for making science more Socratic and less Faustian. As to the prospects of such a Socratic-Christian agenda, I, however, am not of good cheer, nor have I much confidence that even the widespread adoption of something like it, besides being extremely implausible in the present climate of thought, would be very efficient in holding the dark forces of technoscience in check and alleviate its tremendous harmful and dangerous impact on mankind. Although the struggle against the totalitarian rule of naturalism in Academe will not be quite as hopeless as and much less physically dangerous than the heroic struggle against the brown and red devils in Nazi Germany and Communist Russia during their heydays, the programme sketched at above will doubtless encounter tremendous opposition and may indeed seem exceedingly naïve, nay as Bedlamite nonsense with scanty, if any chances at

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[2150] [Mali87] p. 67.

[2151] See p. 499 et seqq. below.

[2152] As pointed out in [Ehre81], these attempts to amend the problems caused by technology tend, however, to generate new, unforeseen problems, which also need to be amended, thereby creating an apparently endless vicious circle of measures and countermeasures. Similarly, [Tenn97] uses the term "revenge effect" to signify the unintended side-effects, which accompany most technical 'advances' and necessitate further technical measures.

[2153] *Ev. Matt. 10:16*

[2154] *Ep. Eph. 6:11*

all, to gain even marginal acceptance in current Academe – indeed this may be so, but, still, if we do not try to fight evil we are sure to be overcome by it. And to be a Bedlamite for Christ every true Christian should consider a great honour, as foolishness to the world is known to have created many great saints.

In 1947, the Jewish existentialist philosopher Jacob Taubes published a book entitled *Abendländische Eschatologie,* in which he put forward some highly disturbing ideas, which, in a sense, propose the very opposite to Voegelin's interpretation of history, to which we have so frequently had recourse in this study.[2155] According to Taubes, we are to cheer all Gnostic-revolutionary movements, which bring mankind closer to the end of history, as only the end can disclose the meaning of history. Thus, rather than trying to establish order and bolster goodness, virtue, and beauty in the world, we should affirm the revolutionary chaos that will undermine order and show the way to Armageddon. Although Taubes' proposal for political action is of course perverse – God forfend its implementation! –, the suspicion cannot be evaded that he here really has spotted the cloven hoof of modernity and its technoscientific mania, that, what mankind is up to through technoscience, "the technological bluff" as Ellul so aptly named it[2156], is, in fact, the implementation of the Apocalypse and the end of the world.[2157] For it seems to me impossible to gainsay the likeliness of the prophecies made by many so-called Doomsday prophets that mankind by its idolatrous worship of Baconian-Comtist technoscience with all its impetuous arrogance and boundless pride is heading towards some kind of terrible catastrophe on an even grander scale than the catastrophes that came out of the Hegelian, Marxian, and Nietzschean cults of the national state, the working classes, and superman, perhaps even an act of ultimate gnostic self-annihilation.[2158] Nay, this catastrophe has already begun to happen through the modernist onslaught on and attempted destruction of the Christian-Platonic basis of ethics, aesthetics, and metaphysics. But such a grand finale, granted that it is a plausible outcome of the Luciferian scientific-technological pursuit, would indeed finally unravel the true significance of the murder of God, the apotheosis of man, and the modern idolatrous existence without grace and hope, shut off from the wellsprings of being, "sur le soleil de Satan", as Bernanos so forthrightly put it. Indeed, the Christian religion teaches us – as do other religions – to expect a terrible end of the present world, but also consoles us by the promise that for the faithful the tribulations of this Apocalypse will be the start of something far better to come. In any case, as despair is a mortal sin and both our Lord and history dissuade us from speculating about when and how the end will come, we are obliged to struggle for the good against the destructive forces – or as some of us would prefer to put it, for Christ against Antichrist.

2155 [Taub91]

2156 [Ellu90]

2157 As pointed out by [Coul92] p. 251 et seqq., Romantic pessimism, nihilism, and Satanism – *la fascination de l'abîme* – have a similar anticosmic import. This may also remind us of St. Augustine's understanding of evil – based on *Ev. Jo. 1:3* – as in its essence a *non-ens,* a dark eddy of nothingness, in which any element of positive being is lacking. This view of evil also impels the great Bishop of Hippo to construe all acts of sin and wickedness as ultimately the expressions of a furtive yearning for self-annihilation, the overpowering pull of the Satanic void (see [Braw94b] p. 97). Moreover, [Schl61] p. 49 et seqq. provides an illuminating theological interpretation of the demonic "spirit of raging haste" that ensued upon Christ's victory over the powers of darkness on the Cross and the consequent judgement and expulsion from Heaven of the prince of these powers, whose desperate and rage-laden activities hereupon, in the teeth of their own predicament of being "left only with time and no longer with eternity", are mirrored in the ever-accelerating apocalyptical catastrophes of history, as it has since been unfolding. Cf. also [Braw95] p. 96 et seqq., [Benz77], and footnote 2091 on p. 453 above. I will expand on the topic of immanentised eschatology and science in the sections starting on p. 484 and on p. 499 below.

2158 See [Lesl98].

3.4 COMPUTING AND THE EVERGREEN THEMES OF GNOSTICISM – FROM THEURGY TO VIRTUAL REALITY

Bruno's assumption that the astral forces which govern the outer world also operate within, and can be reproduced or captured there to operate a magical-mechanical memory seems to bring one curiously close to the mind machine which is able to do so much of the work of the human brain by mechanical means.

Frances Yates[2159]

Any sufficiently advanced technology is indistinguishable from magic.

Arthur C. Clarke[2160]

They are the three Magi, in the traditional tableau, come to kneel at the advent of something new in the world. Only this cradle does not contain a Christ child but a treatise on logic.

William Barrett (on Russell, Whitehead, and Wittgenstein in the early 1910s)[2161]

To clarify the intent and plan of this section we will first recapitulate the main course of the investigation embarked upon. We started by a discussion of some different classifications of worldviews, of which we picked out Poortman's scheme of six metaphysical standpoints as the most natural and useful for our purposes. We also pointed out that modernity and its associated 'scientific worldview' – as well as the recently much-touted postmodernity – are both closely bound up with Poortman's *Alpha* standpoint, i.e. *monistic materialism* or *naturalism.* Although we were not able to go into a full discussion of the merits and problems of the different standpoints, we argued that *naturalism* is untenable, being at loggerheads both with large corpora of 'anomalous' observations and data and with our daily experience, and that this will be – and, indeed, has always been – obvious to anyone, who takes the time to investigate the evidence at some depth.

We also noted that the advocates of *naturalism* tend to defend their views in a far from disengaged manner, regularly relying on strained and tendentious arguments, neglect of or outright repression of counter-evidence, vehement rhetoric, ridicule, *argumenta ad hominem,* implicit threats, and the like, thereby revealing a peculiar *magic* attitude to reality, as though the world was to be forced into the desired shape by rhetoric incantations rather than being subject to man's open quest and exploration. By such doubtful, but in practice often very efficient methods, which *de facto* boil down to a kind of spiritual violence, the adherents of naturalism have been able to gain control over many important domains of discourse and scientific research to such an extent that no anti-naturalist opposition is longer brooked within these realms of study. Obviously, the entrenched fervour with which naturalism is espoused and defended will not be unrelated to the fact that naturalism is a presupposition and starting-point for a wide range of ideological agendas that function as *ersatz religions,* such as scientism, secular humanism, positivism, skepticism, Marxism, Freudian psychoanalysis, etc. But why do these pseudoreligious 'isms' command so much popularity? And how can it be that such an intrinsically counterfactual and *prima facie* unattractive approach to reality as *naturalism* and its miscellaneous pseudoreligious outcroppings have been able to gain such prominence within both scientific and extra-scientific modernity and are defended with such strange vehemence?

By recourse to a large body of research, the findings and theories of such sharp-sighted scholars and thinkers as Voegelin, McKnight, de Lubac, Latour, Lindbom, Benz, Spengler, Yates, Kuhn, Feyerabend, and many others, we attempted to cast some light on these questions in order to make the unsettling present comprehensible by uncovering and regaining the beclouded past. In the resulting analysis, tentative, schematic, and stitched together from somewhat disparate elements as it admittedly is, the course of Western history was interpreted with recourse to, *inter alia,* the following concepts and intellectual structures:

2159 [Yate66] p. 225

2160 [Clar73] p. 39

2161 [Barr78] p. 2

1) a *gnostic* attitude of extreme discontent with the present world, rejection of its divine ground, and unswerving belief in the possibility of self-salvation through some kind of absolute, saving knowledge *(gnosis)* supposed to provide a transcendental escape from man's current plight

2) the *immanentisation* of this *gnostic* impulse – initially often through an intermediary stage of *millenarianism –,* whereby it is redirected from the transcendental to the immanent realm, typically coming out as *progressivism, utopianism,* or *activism* and leading to a *gnostic-utopian* break with the past and a thrust to bring about the innerworldly transfiguration of reality *by human action,* as legitimised through some form of constructed 'second reality', which, making the utopian prophecies look plausible and veiling the *libido dominandi* of the *gnostic* activists, must never be allowed to be questioned

3) a related *secularising* tendency gaining momentum partly through the monopsychic and naturalist drift of the Averroist and Alexandrist varieties of Aristotelianism, but primarily through *Ockham's* and the *nominalists'* attack on the traditional Platonic-Christian understanding of reality as grounded in the universal ideas of the divine *Logos,* inaugurating a general obsession with the levelling of all hierarchies, whereby, for one thing, God is little by little pantheistically folded into nature and seemingly disappears

4) a complementary tendency of *sacralisation,* which made its first appearance in the West through some forms of derailed enthusiast mysticism and through the ferment of occultism and the black arts so fervently pursued by the intellectuals of the Middle Ages, but took on a wider significance only during the Renaissance through the revival of Hermeticism, the Kabbalah, and Neoplatonism, conducing to the aforementioned tendency of flattening by making the divine and the human indistinguishable, as man was elevated into a god-like magus and society into the utopian dream of an earthly paradise, and *eo ipso* also paving the way for the technoscientific reconstruction of the world by strengthening man's will and *libido dominandi* and by eroding his religious scruples and restraints as to such activities

5) the resulting massive *immanentisation* of the legacy of Christian, Platonic, and occult Hermetic-Cabalistic ideas and notions so singularly important for the emergence and development of science and technology

6) the establishment of the *modern constitution,* whereby, through the division of the world into a subjective and an objective part *(the Great Divide)* and the side-stepping of God, who was declared non-existent, possibly evil, or, at least, irrelevant, technoscience was exempted from the fetters of the *anthropological matrix* and becomes free to reshape and manipulate reality as well as our notions about it without almost any restraint whatsoever

Thus, *naturalism,* it transpires, serves the purpose of setting man free and making the modern-gnostic attempts to transfigure reality and change the order of being look reasonable, as a reality grounded in the divine will not plausibly gain by or even be amenable to the execution of man's modification projects, however grand these may be in their conception and by however grandiloquent rhetoric they may be sugar-coated. Certainly, much of the odd, incantation-like discourse of the innumerable varieties of modern gnosticism stems from the circumstance that these projects are founded in fantastic dreams and unashamed deceptions, which can only be camouflaged by conjuring up a confounding pseudo-reality that obscures the hard, real reality. However, deep in the recesses of their hearts even the conjurers themselves seem to recognise that they are cheating, being told on by the captious, leather-lunged, and lockstep, but, on a closer look, self-deceiving rather than persuasive way the very act of the conjuration is perpetrated, as though the real motive of the conjuration was some kind of stealthy benefit or hidden sop that must not be revealed.

Finally, the present state of science, characterised by the exclusive predominance of naturalistic point of views, was discussed. The extraordinary claims often made about the pre-eminence of the naturalistic 'scientific worldview' were found to be, on the whole, invalid and unfounded, and a plea was made for a less arrogant, more pluralistic and more open-minded science. I also gave some arguments in favour of the view that 'mere Christianity' represents an approach to reality more sensible and rational than the current temerarious course of naturalistic, technoscientific modernism.

Now, I will briefly attempt to relate the results gained so far to the realm of computing in order to deepen

our understanding of what the computer *really* is, its metaphysical context, its roots in some of man's more bold spiritual enterprises, and its historical importance. It will not be possible to go into much detail here, since it would be easy to devote a book-length monograph to each of these topics. Instead, we will have to content ourselves with charting the territory – still largely *terra incognita*[2162] – with a very coarse pen.

3.4.1 THE OCCULT AND MYSTICAL ROOTS OF COMPUTING

> *Unsre ganze Kultur hat eine Entdeckerseele. Ent-decken, das was man* **nicht** *sieht, in die Lichtwelt des inneren Auges ziehen, um sich seiner zu bemächtigen, das war vom ersten Tage an ihre hartnäckigste Leidenschaft. Alle ihre großen Erfindungen sind in der Tiefe langsam gereift, durch vorwegnehmender Geister verkündigt und versucht worden, um mit der Notwendigkeit eines Schicksals endlich hervorzubrechen.*
>
> *Oswald Spengler*[2163]

Like most modern artefacts, the computer is part of a metaphysical programme and realises long-standing dreams and ambitions with a devious history traceable in myths and legends as well as in the various religious and Hermetic-occult traditions, which we have ever and anon lit upon earlier. And like all scientific pursuits, the various agendas of computer science are also deeply affected by their own metaphysical presuppositions, which regulate and restrict the way problems are formulated and new results arrived at. The history of the computer has been written many times and the identity of the key figures and key events well established[2164], as has the formative importance during its gestation of a climate of opinion dominated by logical positivism, scientism, progressivism, physicalism, and kindred dour strains of thought, although it would certainly be too simplistic to equate the outlook of the computer pioneers with these isms.[2165] Despite the harsh anti-meta-

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2162 Amongst the few works that concern themselves with such topics at some length, [Cohe66], [Heim93], [Davi98], [Nobl99], [Hill99], and [Coyn99] should be mentioned. In particular, I will here lean heavily on [Cohe66], an excellent and amusing probe of the historical, spiritual and psychological depths from which computing emerged, and [Davi98], who, in spite of the occasionally somewhat awkward hipness of the writing style, which might instil unwarranted misgivings about the author's seriousness and reliability, provides a valuable overview of a dazzling number of, at times quite arcane, aspects of what the author calls "techgnosis", i.e. the fundamentally gnostic temper of modern technoscientific culture, thereby displaying a good sense of synthetic understanding and subtle points together with a polymath erudition out of the ordinary. A large number of shorter pieces by the same author are available at http://www.levity.com/figment.

2163 [Spen97] p. 1186 et seq. Cf. [Cohe66] p. 95 et seqq., [Port49], and [Samb81] on psychological and mythological motifs in technology and science.

2164 Some survey accounts of the history of computing I have found valuable and useful, albeit very different in scope and approach, are [Gard68], [Gold72], [EE73], [SBN82], [Shur96], [CA96], [Ceru99], [Cast99], [Davi00], [Ifra00], and [Ifra01]. [Carl01] reviews a number of recent books on the subject.

2165 Norbert Wiener, for one, albeit for a time a student of Bertrand Russell's and sharing in his devotion to mathematics, logic, and physics, soon became opposed both to Russell's logicism and to logical positivism in general (see [Masa90] p. 45 et seqq. and [Heim80] p. 155 et seqq.) and throughout his life grappled with philosophical, religious, ethical, and psychological problems, as witnessed in many of his publications. And even von Neumann, the unremitting fugleman of scientistic progressivism and campaigner for an atomic war against the communists (see [Poun93] on his game-theoretic arguments for such a war), turned to Catholicism during his last year of illness (see [Heim80] p. 366 et seqq.).

Indeed, there were many other important critics of and defectors from the extreme one-sidedness and nihilism of the positivistic-scientistic agenda amongst the leading scientific and mathematical minds of this time. Gödel's attempt at a new version of Anselm's ontological proof of the existence of God (see [Smal]), Whitehead's hylozoic "process philosophy" (see [Whit69]), and Wolfgang Pauli's interest in Jungian depth psychology and involvement in the gestation of the Jungian conception of synchronicity (see [JP55] p. 136 – or [Jung73] p. 98 – and p. 147 et seqq. and [West84b]) immediately come to mind. By the way, Carnap, Hahn, Gödel – all members of Schlick's positivistic Vienna circle –, as well as Einstein, who, besides, also wrote a short preface to Upton Sinclair's book about telepathy [Sinc62] (but cf. also [Ingl84] p. 317 et seq.), are known to have researched paranormal phenomena or taken part in spiritistic séances (see [Daws97] p. 29 et seq., [Daws99] p. 76, and [Qvarn59] p. 98). Notably, Gödel was a theist and Platonist, who dismissed both scientific materialism and Darwinist evolutionism and unequivocally asserted his belief in a life after death (see [Daws97] p. 6, p. 210 et seqq. et passim and [Berl02]) and whose unpublished papers contain extensive notes on philosophy, theology, and demonology (see [Krei80] p. 218 et seq.). Einstein took a certain, albeit little known, interest in the historical vindication of the Biblical narratives, as witnessed by his fascination with Velikovsky's and A. S. Yahuda's controversial theories (see [Graz78] and [Popk88]), although, if we are to believe [Jamm99], Einstein for the better part of his life stoutly espoused his own deistic, Spinozist – or shall we perhaps instead say Kabbalist? – "cosmic religion" and was stoutly opposed to theism, mysticism, and the belief in personal immortality. The philosophical-theological motives of some mathematicians, whose work paved the way for the computer revolution, are briefly considered in [Davi00]. On de Morgan's interest in psychical phenomena, see [Prin63] p. 18 et seqq. On the correspondence over the theological implications of the mathematical

physical rhetoric of the positivists, their metaphysical standpoint undoubtedly was the *Alpha* one – they almost unexceptionally were proponents of materialism, reductionism, and a modernism, blatantly inimical to and ironical about anything that smacked of religion, occultism, or mysticism. Still, in the computer, which became something of the grail for the strivings of the logical positivists, came together many *immanentised* ideas and motifs with deep roots in the very traditions so keenly rejected and despised by them, most notably the traditions pertaining to the mystical-occult quest for *the perfect language* and *the creation of artificial life.*[2166]

The quest for the perfect language rests on the idea that some kind of primordial, "perfect language" indeed exists. This notion primarily derives from the first chapters of *Genesis,* where God creates the world by His words and, later, shows to Adam the various creatures He has made in order to observe what names our first parent would give them each.[2167] Thus, there is on the one hand a divine, creative language and on the other an Adamitic, nomothetical one,[2168] both having a claim to a particular kind of primordial perfection. In later exegesis, noticeably amongst the devotees of the Kabbalah, the words uttered by God during the creation were often construed as God's creative ideas or as some kind of Platonic ideal numbers or other mathematical constructs that in one way or other gave shape to the world.[2169] In the year 1274, on Mount Randa in Majorca, the quest for the perfect language took a new, eventful turn, as Raymond Lull, the renowned Spanish mystic and *doctor illuminatus*, had a vision, which inspired him to construct his famous *ars generalis* or *ars combinatoria.* This *ars* was a meta-scientific scheme intriguingly blending logic and exemplaristic-symbolic metaphysics so as to semi-automatically deduce not just formal truths about sentences as in Aristotelian logic, but also truths about the structure of *reality* itself by means of various kinds of combinatorial manipulations of the elements of a *tabula generalis* (based on a number of 'divine dignities') through four 'figures', one of which had wheel-shaped movable parts like those of a clock, many contemporary astronomical instruments[2170], or a latter-day calculator.[2171]

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concept of infinity between leading Catholic theologians, including Pope Leo XIII, and Georg Cantor, who, like Wolfgang Pauli, also took a peculiar interest in the Rosicrucian background to the scientific revolution and, unlike Pauli, held somewhat curious views on the perennial issue of who wrote Shakespeare, see [Daub77].

Although today, chiefly as a consequence of the brazen intimidation campaigns of *CSICOP* beginning in the late 70s, scientists have become increasingly wary of discussing such matters openly, interests in the mystical, esoteric, occult, and paranormal have always been rife amongst them. In particular, physicists seem to nourish such an unquenchable enthusiasm for such matters that it would probably be easier to enumerate the noteworthy physicists who never took a positive interest in them than those who did. For one thing, amongst the founders of the Society of Psychical Research were, besides many other famous scientists, the physicists William Crookes, William Barrett, Oliver Lodge, J. J. Thomson, and Lord Rayleigh, of whom the latter two would also become Nobel laureates (see [Belo93] p. 71). Additionally, many well-known physicists, including Jeans, Bohr, Oppenheimer, Schrödinger, and Bohm – to say nothing of the 'New Age physicists', such as Fritjof Capra, Fred Alan Wolf, Gary Zukav, or Michael Talbot – have taken a profound interest in Eastern mysticism and also tried to relate it to modern physics (see [Ingl84] p. 315 et seqq., [Gerh90], and [Jamm99] p. 236 et seqq.). Cf. also [Duse99], [Benz89], and footnote 1473 on p. 297 above. Evidently, the bearings of all kinds of theological, philosophical, and mystical-occult ideas on contemporary science and the interest in these topics taken by leading 20th century scientists are as yet only spottily and unsatisfactorily known and deserve close consideration and systematic study.

2166 In an earlier section (see above p. 215), we discussed some influential "agendas of computing", viz. Pythagoreanism, a "linguistic" agenda, artificial intelligence, man-computer interaction, textual connectionism, geographical connectionism, software engineering, object-orientation, and virtual reality. Each of these agendas is based on a founding metaphor, viz., in turn, the calculator, the *Sprachmaschine* conceived of as a servant obeying written commands, the electronic brain or mind, the universal tool, a (world-wide) web of text, a network of connections, a machine built from components, the idea/instances duality, and the notion of an artificial world.

2167 See [Ross00], [Eco97], [Frän74], [Blum99a], [Yate66], and [Davi00].

2168 Unless the Adamitic language was identified with Hebrew, as was often done, it was usually supposed to have disappeared through the multiplication of tongues, which ensued on the erection of the Tower of Babel. See [Bors95]. Cf. also [RC99].

2169 The probably most famous articulation of this idea will be Galileo's observation in *Il Saggiatore* that the book of nature was "scritto in lingua matematica" with characters of triangles, circles, and other geometrical figures – as, of course, suggested already in Plato's *Timaeus.* On the alphabetical mysticism of the Kabbalists and others, see [Dorn25].

2170 [Pede77] contains pictures and descriptions of many such devices. [McCo79] p. 9 (unfortunately, not stating her source) asserts that Lull was inspired by the *zairja,* a combinatory device used by Arabian astrologers.

2171 See [Llul93], [Eco97] p. 53 et seqq., [Yate82] p. 3 et seqq., [Yate66] p. 173 et seqq., [Ross00] p. 29 et seqq., [Nord98] p. 59 et seqq., and – the magnificently pompous – [Gard68] p. 1 et seqq. The *tabula generalis* consisted of six groups (to wit absolute and relative principles, questions, subjects, virtues, and vices) of nine (or in some variants sixteen) entities (represented by the letters B, C, D, E, F, G, H, I, and K). The divine attributes or 'dignities', or rather a subset of them (viz. *bonitas,* goodness, *magnitudo,* magnitude, *aeternitas,* eternity, *potestas,* power, *sapientia,* wisdom, *voluntas,* will, *virtus,* virtue, *veritas,* truth, and *gloria,* glory), were the most important of these entities, being subsumed under the header 'absolute principles', which, as the constitutive principles of both being and understanding, regulated the organisation of the entire table. The actual operations of the Lullian art through the four figures are too complex to go into here; for a

The Lullian art came to wield an enormous influence during the Renaissance, blending complexly with various other strands of lore popular at this time, including Platonism, Pythagoreanism, the Kabbalah, the occult sciences, mnemotechnics, interest in hieroglyphics and emblematic representation, and the pansophic quest for a universal method, science, and key to nature, the *clavis universalis.*[2172] In particular, Leibniz, who still was very much under the spell of Renaissance Hermeticism and Cabalism, developed Lull's notion of an *ars combinatoria* in momentous ways, hoping to be able to replace illogical disputes on all kinds of questions with a more reliable *calculus universalis* of "blind thought" *(cogitatio caeca)* undertaken in a formal, algebra-like *lingua universalis.* This calculus was a core element of the *mathesis universalis,* his programme for a generalisation of the 'geometrical method' into a universal deductive, mathematical-logic science based on the *characteristica universalis,* the universal symbol system, which Leibniz, like others at this time, imagined as an 'alphabet of thought' in the form of an exhaustive, systematic encyclopaedia of unequivocal designations for all available elementary concepts and terms.[2173] The quest for a perfect, mathematico-logical language, albeit after Leibniz and his rationalist follower Wolf mostly stripped of its transcendental-mystical dimension[2174], retained its attraction through the ages and via, amongst others, Boole and his "laws of thought", Frege, Russell, Whitehead, Gödel, and the logical positivists was eventually instrumental in fathering the electronic computer.[2175] That the dream of the primordial, perfect language refuses to die, but still is vigorous and capable of resurfacing in new forms can be seen from Marshall McLuhan's celebration of the acoustic magic of preliterate language, "the magical world of the ear",[2176] Alan Kay's vision of the computer as a "personal dynamic medium" or "fantasy amplifier"[2177], or Jaron Lanier's idea about a *virtual reality*-based "post-symbolic" mode of communication[2178] and the frenzied enthusiasm such ideas often meet with.

The creation of artificial life and automata is a topic, the fascination for which, being closely coupled to man's fascination with the creation of the world at large and the living beings and himself in particular, is as universal as it is old, as attested by, for instance, the passage in the *Iliad,* where Hephaestus' golden robot maids are portrayed,[2179] the Greek myths about Daedalus' moving statues or Archytas' flying dove of wood, and numerous kindred narratives and stories from cultures and civilisations all over the world.[2180] Although the use made in the pagan cults of idols for the retrieval of oracular responses through voices and gestures and the like cannot, strictly speaking, be adduced as an example of "artificial life" proper, as the idol was not believed to be alive and be able to speak and gesture by itself, but by virtue of its being taken possession of by the spirit of a god, angel, or demon through some kind of theurgic or kindred rite, much like the soul or astral body was

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crisp account hereof, see [Eco97] p. 54 et seqq. The objective of the *ars generalis* was to persuade the Saracen and Jewish miscreants to abnegate their present faiths and become Christians, the mission to which Lull had devoted his life and for which he, perhaps, finally became a martyr. [Yate82] p. 78 et seqq. argues that Lull got his ideas of the *dignitates Dei* as the primary archetypal principles of creation from John Scotus Eriugena, who, in turn, might have found them in, amongst others, St. Augustine and pseudo-Dionysius, whereas others have pointed out the striking similarity between Lull's dignities and the ten *sephiroth* of the Kabbalah as well as with a similar Moslem scheme of *hadras;* see [Llul93] p. 50, [Eco97] p. 66, and [Schu02] p. 73 et seq., where Lull is also reported to have been familiar with the "teachings and methods" of the Ismaili Brethren of Purity, *Ikhwan al-Safa.*

2172 Important figures in the Lullian tradition are, for example, Cardinal Bessarion, Cusanus, Pico, Raymond of Sebond (who by his unflinching rationalism incurred Montaigne's ridicule) Lefèvre d'Etaples, de Lavinheta, Agrippa, Bruno, Alsted, and Kircher. It may also be interesting to note that Descartes, who like Francis Bacon largely disapproved of Lullism, told Beeckman that his own "method" was intended to replace Lull's art. See [Ross61], [SSK88] p. 538 et seqq., [Cohe54], and [Shea88] p. 79.

2173 See [Ross00] p. 176 et seqq., [Eco97] p. 269 et seqq., [Mitt79], [Gust82], [Pose95], [Heim93] p. 93 et seqq., [Davi98] p. 323 et seq., and [Davi00] p. 3 et seqq. Many of Leibniz' most famous achievements, such as the infinitesimal calculus, his symbolic and binary logic, and his mechanical calculator, are part of his more wide-ranging *mathesis universalis* project. Like Lull, Leibniz saw his calculus as a way to propagate Christianity and resolve religious, political, and legal disputes, flabbergastingly supposing that the issues could be settled by means of a session of calculus instead of by war and conflicts. Strivings to overcome religious differences and a proclivity for mystical syncretism are characteristic of many of the personages in the Lullian tradition.

2174 However, the quest for the universal language remained an important topic also with some mystics and esotericists, such as Swedenborg, Saint-Martin, and Fabre d'Olivet. See [JH76] p. 63 et seqq. and [Eco97] p. 112 et seqq.

2175 See [Frän74].

2176 [McLu62] p. 18 et seqq.

2177 See [KG77] and [Rhei00] p. 232 et seqq.

2178 See [Bene91] p. 12 et seq.

2179 *Hom. Il. 18.417-421*

2180 See [Cohe66], [Simo94], and [Mazl93]. Cf. also [Crev93].

held to animate man's body and be able to leave and enter it during certain circumstances[2181], cultic-religious use was nevertheless occasionally made of automata, such as Hero's, Ctesibius' and Philo of Byzantium's ingenious devices, be it relied on in order to deceive or to create a sense of awe favourable for the supervention of genuine psychic phenomena and interaction with the other world.[2182] Such theurgic beliefs will also be implied in the medieval legends of the speaking oracular heads ascribed to the technomagical ingenuity of various supposed sorcerers, such as Gerbert of Aurillac, Roger Bacon, and Albert the Great, of whom the latter was also rumoured to have spent thirty years on the construction of a full-fledged speaking, mobile robot, which however, so the story goes at least, his thin-skinned disciple St. Thomas Aquinas destroyed in dismay.[2183]

Likewise, the peculiar stories about the *Golem,* the anthropoid of clay brought to life by Cabalist magic similarly to the way Adam was manufactured and inspirited by God in *Genesis* or the first man by Prometheus and Athena in Greek myth, will also reflect theurgic practices and beliefs[2184]; another variant of the magically created anthropoid was the notorious *homunculus* reportedly created and bred by the alchemists Jabir, Arnold of Villanova, and Paracelsus.[2185] The *Golem* story – together with its moral of the creature getting out of hand and turning on its creator – is of particular note in the context of computers, as the *Golem* came to be something of a symbol for the bold aspirations of the fathers of the "electronic brain".[2186] According to the MIT researcher Joel Moses, both John von Neumann and Norbert Wiener – just like Moses himself and the AI doyen Marvin Minsky – actually traced their lineage from the most famous of the Golem makers, Rabbi Loew of Prague![2187]

Whereas magic and technology were closely associated in the thought of the Middle Ages and the Renaissance[2188], the decline of the former at the expense of the latter, being the mark of the onset of modernity, was reflected also in the construction of increasingly complex mechanical (and pneumatic) automata – without any recourse to magic. Whereas simple mobile toys, moving and sounding figurines on water clocks, and kindred amusing trifles have been made from very ancient times, the exquisite mirabilia, which began to appear in the late Middle Ages and the sophistication of which culminated in the 18th century will be an altogether different kettle of fish. Such devices, apparently endeavouring to give the lie to the magic animism of yore, are, for example, the famous flapping and crowing iron cock of the 1354 Strasbourg clock or the eating duck, the mobile animals, the music-playing and writing androids, and the speaking heads built by various master mechanicians of the 18th century, such as de Vaucanson, Maillardet, the Jaquet-Droz father and son, or Baron von Kempelen.[2189] Behind these intriguing contrivances, we may discern the onslaught of the mechanistic worldview, which made its first inchoate inroads at about the same time as the mechanical clock was

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2181 See above p. 372. Cf. also [Poor78].

2182 See [Cohe66] p. 15 et seqq., [Drac65] p. 114 et seqq., [SHHV54] vol. II p. 633 et seqq., and [Spra74] p. 141 et seqq.

2183 Id. op. p. 27 et seqq. There were also various other famous speaking heads, such as (possibly) the Biblical *teraphim,* which Rachel stole from her father Laban, or Mimer's head, which Odin used to ask for advice. Gerbert of Aurillac, who, despite his somewhat sinister reputation as a magician, was to become Roman pontiff under the name Sylvester II, is also famous for re-introducing into the Latin West the *abacus,* the prototype of all digital computers. On this interesting personality, see [Rich87].

2184 See [Cohe66] p. 38 et seqq., [Rose34], [Nehe87], [Idel90], [Scho53], [Bére93], [Scho96] p. 158 et seqq., [Rude88] p. 108 et seqq., and [Rude95] p. 138 et seqq. A Jungian interpretation of the Golem is provided in [Knap78].

2185 See [Cohe66] p. 43 et seqq., [Peuc67] vol. II p. 173 et seqq., and [Pint]. On Jabir, known as Geber in the Latin West, see [Krau86] p. 97 et seqq. On Arnold of Villanova, see [Zieg98]. One may speculate that the homunculus idea is somehow related to the Yezidi myth of the competition between Adam and Eve mentioned in, for example, [Ming00] p. 21 and [Korm] part II. On the Gnostic background of alchemy, see [Wils84].

2186 For one thing, Norbert Wiener, himself, like von Neumann, a Jew, wrote a famous book [Wien64a] entitled *God and Golem, Inc.* (cf. [Heim80] p. 372 et seq.). See also [McCu61].

2187 Moses is reported to have told Pamela McCorduck this in [McCo79] p. 13, a book aptly characterised as "the authorized court history of artificial intelligence" by [Bolt84a] p. 251. On Rabbi Loew, see [Boks94], [Sher82], and [Thie55].

2188 See [Eamo83], [Hans78], [Hans86], [Kiec89] p. 100 et seqq., and [Eamo94]. Cf. also [Newm89] and [NG01].

2189 See [CD49], [Boeh56], [Main59], [Cohe66] p. 81 et seqq., and [Bedi64]. The famous flying eagle and jumping iron fly of Regiomontanus (1436-1476) are relegated to the realm of myth by most historians. [Drac65] p. 98 et seqq. and [JT96] p. 114 et seqq. describe some of Ctesibius', Hero's and the other ancient inventors' devices, [Bret54] the Byzantine throne of Solomon. See also the web site http://www.worldtempus.com/wt/1/1415.

introduced in the 13th-14th century[2190], but gained its overpowering impetus only through the reaction against the animism of the Renaissance Platonists in the 17th century.[2191] The immanentisation of the soul implicit in Descartes' demotion of the animals to the status of automata and made explicit by de La Mettrie's extension of this demotion to man was apparently somehow vindicated, or at least suggestively toyed with, by the increasingly refined and seemingly intelligent behaviour of the various mechanical automata – much as Pascal's, Leibniz', Babbage's and others' mechanical calculators seemed to vindicate the immanentisation of man's ratiocinative abilities.[2192] Both these immanentisations of what originally were daring mystico-occult projects were brought together in the construction of the "computer" or "electronic brain", as the onset of the Second World War provided the necessary pretext and wherewithal for such a bold endeavour.[2193] Ironically, von Neumann, Wiener, Turing, and the other pioneers of computing really imagined that they were a kind of modern mathematico-scientific master magicians about to electronically substantiate the age-old dreams of the Golem, bravely speculating about self-duplicating automata and the coming "singularity", through which the Golem would turn the tables on its creators and outdo them in intelligence and cunning, when what they in fact were about to bring forth was but a glorified typewriter and multi-purpose accounting machine, which indeed would change the world, but in quite other ways than they were able to foresee – verily, a nice validation of Koestler's thesis that scientists may be excessively gifted and brilliant, but sleepwalkers withal![2194]

Besides these two constitutive themes, *the quest for the perfect language* and *the creation of artificial life,* there are many other notions and topics in computing derived from or related to the entrepôts of ideas provided by religion and occultism, such as:

- *Number mysticism.* Number mysticism was until rather recently part and parcel of the mathematical heritage coming down to us from Babylonia, Egypt, Greece, and elsewhere, and in particular so in the Pythagorean-Platonic tradition, from which modern mathematical science originally sprang. Notably, much mystique and speculation have since olden times surrounded the natural numbers, and, in particular, the number *One,* the *monad,* which the Pythagoreans referred to by names such as Apollo or Zeus, as well as the first two natural numbers, the so-called *dyad,* which they named Rhea, the mother of the gods, as all natural numbers – and, thus, in their view, the entire cosmos – could be generated from the *monad* and the *dyad.*[2195] Likewise, in Plato's metaphysics and theory about the ideal numbers, *The One* and *The Unlimited Dyad,* the ἀόριστος δυάς, played a crucial, albeit somewhat abstruse,

[2190] Notably, it was at this time that Nicole Oresme likened the cosmos to a mechanical clock made by God and Raymond Lull put together his clock-like wheels for the automation of thought. See [Pede77] p. 58 et seqq. and [Dale80]. On the importance of the clock as a *defining technology,* see [Bolt84a] p. 24 et seqq. In contrast, [Soll64] and [Soll67] argue that mechanical invention originally was driven by an urge to understand creation by simulating it, which is to say that mechanics proceeds from *mechanicism,* or mechanical philosophy, rather than the other way round – and that the usefulness of such inventions for this or that mundane purpose is but a contingency or degeneration phenomenon. The notion of the universe as a *machina mundi,* quite prevalent in the Middle Ages, seems to go back to the wording of a passage in Chalcidius' translation of *Timaeus.* See [Funk86] p. 317 et seqq. Cf. also [Dijk86].

[2191] See [Cohe66] p. 68 et seqq. Cf. also [Yate64] p. 450 et seqq., [Rose41], [Vart73], and [HKS93].

[2192] Already St. Thomas Aquinas reportedly regarded animals as machines (see [Soll64] p. 19). Here, we can only refer in passing to the – largely unenthusiastic, cautionary, and bodeful, if not openly Romantic-animistic – reaction in literary fiction to the reductionist-mechanistic agenda with its large treasure-trove of tales about automata and artificial life, such as Mary Shelley's monster of Frankenstein – the archetypal warning against the "mad scientist" (see [Flor75]) –, Karel □apek's *robot,* now well-established in the technological vocabulary, or Gustav Meyrink's *Golem,* drawing on the aforementioned piece of Cabalistic lore. See [Cohe66] p. 50 et seqq. and [Chap47].

[2193] Cf. p. 230 above.

[2194] [Koes64]

[2195] See [Gorm79] p. 133 et seqq. It should be noted that the symbol for the number "0", which was invented in India, was introduced in Europe, together with the Arabian system of numerals, only in the Middle Ages, purportedly by Gerbert of Aurillac (pope Sylvester II). Next to the monad and dyad, the four first natural numbers, from which the point, line, plane, and solid, respectively, can be generated, were regarded as the most venerable numbers by Pythagorean numerologists. At the next remove, the "decad" of the 10 first natural numbers, was also much venerated, the perfect number 10 being the sum of 1+2+3+4, the famous Pythagorean *tetraktys.* Notably, Pythagoras' opposites, constituting, as it were, the principles of being (limited-unlimited, odd-even, one-plurality, right-left, male-female, at rest-in motion, straight-crooked, light-darkness, good-evil, square-oblong), were also 10 in number. Albeit in general more inclined towards alphabetic-cryptographic mysticism than numerology, the adepts of the Kabbalah also honoured the significance of the number 10 by their belief that there are ten *sephiroth* or aspects of God and that the world was put together by God from the ten *sephiroth* and the 22 characters of the Hebraic alphabet. See [Eco97] p. 25 et seqq. Cf. also [West74], a well-known and erudite occultist's treatment of these topics.

generative rôle.[2196] During the Renaissance, mystical numerology, being a core element of the Platonic revival, gained strongly in popularity and came to play an important rôle in the “scientific revolution”.[2197] About this time, the binary calculus was developed by Leibniz, who used it for a (mistaken) attempt to interpret the Chinese divinatory system *I Ching,* the Book of Changes, of which Leibniz believed Hermes Trismegistus to be the author.[2198] Shorn of its numerological-mystical connotations, Leibniz’ binary calculus, besides being the precursor of Boole’s logic, now provides the mathematical basis for the low-level operation of all computers.

- *Anima mundi, intellectus agens, collective unconscious.* The belief that there is some kind of deeper level of being, a Platonic *World Soul (ψυχή, anima mundi),* an Aristotelian *Active Intellect,* (*νοῦς ποιητικός, intellectus agens),* or a Jungian collective unconscious,[2199] through which we all – and indeed all reality – are interconnected, is omnipresent in esoteric and mystical lore, albeit always suspect to Christian theology as abutting to pantheism and self-deification. A strong element of such connectionist mystique seems to be implicit in the rampant religious overtones of the discourse on the Internet, ubiquitous computing, “the noosphere”, and kindred topics,[2200] being cut from the same cloth as the mystique that once surrounded electricity, telegraphy, and telephony.[2201]

- *Microcosms of different kinds[2202], fantasy and theatre worlds, gardens as symbols for Paradise or cosmos, dreamscapes/mindscapes[2203], astral, celestial, and infernal worlds and travels[2204], possible and multiple worlds[2205], memory palaces[2206], etc.* These notions and themes, originally imbued with a more or less profound spiritual-philosophical significance, doubtless provide the background for the pull and fascination *virtual reality* and *cyberspace* exert on human imagination.[2207]

2196 See *Ar. Met. I.VI.* A lucid account of Plato’s “unwritten” number theory can be found in [Dill77] p. 3 et seqq. Interestingly, Plato connected the numbers of the *tetraktys* not only with the geometrical point, line, plane (triangle), and solid (pyramid), but also with a hierarchy of four different modes of cognition, to wit *One* with **νοῦς**, *intuition, Two* with **□πιστήμη** (or **διάνοια**), *science* or *discursive knowledge, Three* with **δόξα**, *meaning,* and *Four* with **α□σθησις**, *sensory perception.*

2197 See [Heni74], [Koyr58], and [Koyr43], who (on p. 425), however, following Brunschvicg (see [Brun27] p. 37 et seqq. and [Brun29] p. 69 et seq.), implausibly posits “two … Platonic traditions, that of mystical arithmology, and that of mathematical science” and even cavils at Burtt for not recognising this anachronistic and recherché bipartition. This remark, by one of the most eminent 20th century historians of ideas, provides yet another cautionary example of the odd malpractice popular with the earlier generations of progressivist intellectual historians of dividing up integral systems of thoughts and even individuals in two parts, one of which is praised as progressive and forward-looking, whereas the other is rejected as insignificant, backwards, and hokey-pokey “occultist”, “mystical”, or “religious”. Fortunately, this way of writing history now largely has fallen into disrepute and abeyance.

2198 See [Eco97] p. 284 et seqq. and [Heat72]. In the early 1940s, McCulloch and Pitts claimed in their influential paper [MP43] that the operation of the brain neurones is binary, making an overwhelming impact on the computer pioneers with their fascination for the brain-machine analogy. Cf. also [LE84] p. 67.

2199 See above p. 370.

2200 See [MP89], [McLu94] (cf. also [Davi98] p. 252 et seq.), [Lévy97] (in particular p. 91 et seqq.), and [Lévy00].

2201 See [Davi98] p. 39 et seqq., [Benz89], [Stan99b], [McLu94], and [Czit82].

2202 By *microcosm,* I do not here intend to refer to the doctrine of the parallelism between man, or man’s soul, and the *macrocosm* (on which see [Cong22] and [Boas73]), but I use the term in a more general sense to designate any artificial or imaginative “small world”.

2203 These terms are used in some mystically oriented “New Age” literature, such as [Vanc89], [Vanc90], and [KW99].

2204 See [Zale87], [Coul91], and [CF95].

2205 The idea of a multiplicity of *possible worlds,* most famous through its pivotal position in Leibniz’ philosophy, can be traced back to Duns Scotus and late medieval philosophy, largely being a corollary to the emphasis laid on God’s unrestricted omnipotence in post-1277 Scholastic theology and philosophy (see above p. 405 and [KKP88] p. 355 and p. 826 et seq.), whereas the notion of *multiple worlds* goes back at least to the ancient Epicureans and was resuscitated by Cusanus in the 15th century and celebrated by Bruno in the 16th (cf. [Will98]). [Keep93] construes Leibniz’ famous allegory in the *Théodicée* [Leib69] of the multiple possible worlds, of which God deigns to create the best one, as a prefiguration of virtual reality. See also [Pose95] p. 128 et seqq.

2206 See [Yate66]. Cf. also [Davi98] p. 198 et seqq.

2207 Cf. [Gele91] p. 181 et seq., [Heim93] p. 116 et seqq., [Bene91] p. 14 et seqq., [Rhei91] p. 378 et seqq., [Bauw97], and [Wert00]. See also above p. 259.

- *Platonism.* Although not always realised, computing is imbued with Platonism at many different levels, nay, can be construed as applied Platonism.[2208] Not only is the programmer acting as a demiurge, forming, at the noetic level, his own *ideas* into programme code, which then the compiler/interpreter, much like the *soul* of the Platonic scheme, projects onto the formless 'matter', which in the computer consists of binary numbers rather than the geometrical figures, of which Plato believed matter was constituted. Likewise, the binaries of a computer programme constitute a *form* from which multiple *images* can be generated. In particular, the conceptual basis of object-orientation is a kind of applied Platonism, where *classes* correspond to *ideas, forms, essences,* or *secondary substances,* and *instances* to *hypostases, subsistences, existences,* or *primary substances.*[2209]

As a consequence of the immanentisation of these themes – and surely others as well[2210] –, the appreciation of their spiritual roots and former meanings is now almost entirely lost, or perhaps rather surreptitiously reversed, although the religiously loaded, often almost gnostic-mystical discourse – often denounced as "hype" – on such topics as virtual reality, artificial intelligence, the *Internet,* object-orientation, etc. reveals the deep metaphysical concerns disguised by the almost ostentatiously disinterested pre-occupation with the purely practical, technical, or formal – not to say superficial, trite, or anodyne – surface aspects typical of the way research is pursued in most branches of computer science.[2211] But in spite of this quasireligious penumbra the materialist-nominalist tendencies of the fathers of computing still largely bear sway in computer science – as, indeed, in science in general. Below, we will consider to what extent the computer experience lends support to or undermines such a metaphysical standpoint. But first we will have to cast a quick glance on the far-reaching speculations about the millenarian rôle of the computer, another intriguing aspect of the 'gnostic' aura of computing.

[2208] See [Davi98] p. 124 et seqq.

[2209] See footnote 551 on p. 124 supra.

[2210] See, for example, [Bauw97], who points out how some esoteric-religious concepts, such as Indra's net (cf. also [Davi98] p. 319 et seqq.) and the Akashic Records, provide elucidating parallels to the dynamics of cyberspace, the basic magical aspect of which he also stresses. The notion of "avatars" in virtual reality systems also illustrates the quasireligious character and claims of this kind of technology (see [Dame98]).

[2211] Tellingly, the most probing analyses of the ulterior motifs and forces behind computing, its philosophical implications and underpinnings, as well as its wider consequences and prospects almost unexceptionally come not from computer scientists, but from outsiders, such as, just to mention a few names, Marshall McLuhan, a Catholic professor of English literature, John Cohen (author of [Cohe66]), a professor of psychology, J. David Bolter (author of [Bolt84a], [Bolt91], and [BG99]; see also http://www.lcc.gatech.edu/~bolter), a doctor of classics, Michael Heim (author of [Heim93], [Heim98], and [Heim99]; see also http://www.mheim.com), "a freelance philosophy teacher", Richard Coyne (author of [Coyn95a] and [Coyn99]; see also http://www.caad.ed.ac.uk/~richard), a professor of architecture, and Erik Davis (author of [Davi98]; see also http://www.techgnosis.com), a self-employed lecturer and writer on technoculture, whereas the insiders of computer science seem to be almost uniformly unwilling or incapable of engaging their own motivations and metaphysical presuppositions. There is a striking similarity between this lassitude and the inability of scientists in other areas, such as Darwinist biology, to transcend their own metaphysical presuppositions or even to perceive that they exist and can be justifiably questioned, whereas, to outsiders who do not share in them or are knowledgeable in areas that possibly invalidate them, the strangeness and dubiousness of these presuppositions will stand out conspicuously.

3.4.1.1 Cybernetic Joachimism – The Computer as a Chiliastic Icon

> *But perhaps the most poignant symptom of the projection of a lost interiority lies in the new electronic mysticism. Images of a global, electronically mediated collective unconsciousness, of Teilhard de Chardin's omega point, and of machines crossing over into a new and superior form of personhood are rife on the Net. Channelers channel onto the Net. Pagans conduct rituals in cyberspace. Most of this is unbearably silly, but as a widespread phenomenon it is difficult to dismiss.*
>
> *S. L. Talbott*[2212]

What is the *real* significance of the computer, its rôle in the history of mankind and human civilisation? For such a question to be meaningful, a conception of history as some kind of progression, where the significance of artefacts such as the computer is made probable, will obviously be needed. Granted that the computer can be assigned a crucial rôle in such a scheme of some kind, there will also be the axiological issue of how to assess the envisioned impact of the computer – is the computer for better or for worse, is it part of a coming or present utopia or dystopia, is it Saviour or Antichrist? The computer figures largely in most speculations about the future[2213], often wrapped up in a typical gnostic-millenarian, Joachitic rhetoric, by which grand hopes about some kind of imminent breakthrough that will forever alter man's mode of existence are attached to it, in effect rendering it what we may call a *chiliastic icon.* Potently conducive to the view of the computer as such a chiliastic icon is also the peculiar rôle that science fiction literature and films play both in the formulation and amplification of futurist scenarios, where the potentialities and possibilities of computing can be elaborated and investigated with the abandon typical of the genre. Notably, such mythopoeia has wielded a palpable influence on some branches of computer science, in particular in the fields of artificial intelligence and virtual reality.[2214]

As pointed out above, the fathers of computing, who, being active during the heyday of logical positivism and general scientistic intoxication, came to hold that they were, as it were, mathemagicians about to call into life the electronic Golem, indulged in much heady speculation of a peculiarly gnostic flavour as to the implications of this act of dauntless sorcery, the ultimate realisation of the dream of the alchemists and Kabbalists of yore. For one thing, the study of self-replicating automata, of which so-called cellular automata (such as Conway's famous "game of life") particularly riveted their attention, inveigled many of them into believing that they had found nothing less than the key to the very mystery of life.[2215] Additionally, their imagination was much caught by the idea that it would be possible to translate into machine-readable form the contents of the human mind, which they, blithely taking the strange leap of generalising Shannon's information theory into a general pan-informationist ontology, more or less as a matter of course identified with the information content of the physical states of the human brain. If one could figure out how to tap the brain of its encoded information, it would, they were confident, be possible to upload this into a computer and even transfer it over a wire, thus making the age-old gnostic dream of the sloughing of the flesh for a discarnate mode of existence come true.[2216] They also liked to brood over the notion of a forthcoming turning-point in history, the "singularity", by which the intelligence of the "electronic brain" they had devised would, *mirabile dictu,* overshadow even the extraordinary wits of its own creators.[2217] It may seem that

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2212 [Talb95] p. 359

2213 See footnote 1570 on p. 322 for some references to works of such futuristic speculation.

2214 Cf. above p. 270. Cf. also [Dery96].

2215 See [Wool93] p. 74 et seqq., [Hayl99] p. 239 et seqq., and [Nobl99] p. 165 et seqq. for brief accounts of these speculations, which were instrumental in giving birth to the fields of artificial life and complexity and chaos theory. Cf. also [Heud99b]. On artificial life research, see [Levy93], [Emme94], [Lang97], and [Resn98]. Cf. also [Leon97] and [Sylw98]. Surveys of the field of complexity theory are provided in [Page89], [Wald93], [Holl95], [CS95], [BG98], and [Holl98]. Cf. also [Cast97]. [Midg94] p. 152 et seqq. tracks the current "posthumanist" crave for discarnation through the construction of artificial life back to the Marxian scientist and historian J. D. Bernal's odd space utopia *The World, the Flesh and the Devil* published in 1929.

2216 See, for instance, [Wien64a] p. 36. On "techgnosis" in general, see [Davi98]. Cf. also [Alex97a-b].

2217 The expression "singularity", as distinct from the idea, goes back to a remark by von Neumann, but has gained popularity only rather recently, mainly through the writings of Vernor Vinge (see [Ving93]). The term is also used by chaos theorists to designate the points of transition, at which some kind of order emerges out of chaos, supposedly of its own accord. There is even a *Singularity Institute for Artificial Intelligence* dedicated to the task of bringing about the singularity, hosting its own web site at http://www.singinst.org/index.html.

nowadays, as the computer no longer is the exclusive and excessively expensive plaything of élite mathematicians and scientists, but a ubiquitous commodity thing used and programmed by all and everyone, it would hardly be possible any longer to credibly construe such a commonplace, imperfect, and often terribly inadequate and foolish device as an "electronic brain" destined to ultimately domesticate man by virtue of its insuperable intelligence, but nonetheless this view is still cherished by many luminaries and aficionados of "strong AI", such as Marvin Minsky, Raymond Kurzweil, Hans Moravec, and Bruce Mazlish.[2218] For example, Mazlish enthusiastically predicts the imminent arrival of the "fourth discontinuity", when man will receive the last blow – after the ones already dealt by Copernicus, Darwin, and Freud – of being eclipsed in intelligence by a machine, thereby becoming once and for all ousted from the central venue of the cosmos he used to occupy and deprived of his illusory pre-eminence and domination over cosmos, the animals, the subconscious, and the machines.[2219] Likewise, Hans Moravec, director of the mobile robot laboratory at Carnegie-Mellon, hails the coming "postbiological" era, exclaiming in the prologue of his influential book *Mind Children:*[2220]

> *What awaits is not oblivion but rather a future which, from our present vantage point, is best described by the words "postbiological" or even "supernatural". It is a world in which the human race has been swept away by the tide of cultural change, usurped by its own artificial progeny.*

Moravec contends that postbiological, superintelligent robots will in the future be able to engineer their own evolution so as to become so incredibly intelligent that our imagination will fail us entirely in delineating their fantastic capabilities.

Somewhat ironically, the interpretations of the historical significance of the computer taking the shine out of these ultra-scientistic pipe dreams on the future rule of the hyper-intelligent machine were formulated by two Catholic thinkers, albeit admittedly of a somewhat unconventional, not to say unorthodox temperament. These two scholars, Marshall McLuhan and Pierre Teilhard de Chardin, have wielded a seemingly unabating influence on computer historiosophy all since the 50s, and their ideas still largely keep the ground today, although the lasting relevance of McLuhan's core insights – in spite of his controversial persona and oracular way of putting forth his ideas – will be much more widely acknowledged than that of Teilhardism, which, however, has secured an all the more vociferous following in certain utopian, strikingly techgnostic quarters.

In McLuhan's construal of the past, the main caesurae of history, Saint-Simon's "critical periods", are marked by the shifts in media, as epitomised by his famous quip "the medium is the message".[2221] By this for McLuhan so typical catch phrase, were spotlighted "the structuring powers of media to impose their assumptions subliminally"[2222], amputating and extending man's being and senses in subtle ways and, thus, changing "the ratio of the senses".[2223] He also makes a distinction between two types of media, "cold" and "hot", which can be illustrated by the difference between a photograph and a cartoon.[2224] Cold media, such as

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[2218] Some recent pleas for such a view are [Mora88], [Mora90], [Kurz90], [Kurz99], [PC96], [MW92], [Diet94], [FGH95], [Mazl93], and [Warw97]. Cf. also [RGKS+02]. The main adherents of these views are presented in [Nobl99] p. 143 et seqq., [McCo79], and [Crev93], whereas [Hayl99] attempts to outline the history of "how we became posthuman". Cf. also [Bolt84a].

[2219] So [Mazl93]. In actuality, man's pre-Copernican position at the centre of the cosmos was not one of honour, but one of humility close to the infernal pessimum of a hierarchical universe where the empyrean periphery constituted the optimum.

[2220] [Mora88] p. 1

[2221] [McLu94] p. 7 et seqq.

[2222] [McLu62] p. 216

[2223] McLuhan acknowledged his own intellectual debt to another Canadian scholar, Harold Innis, who had put forward his ideas in [Inni99] and [Inni86] already in the early 50s. Cf. also [Patt90] and [Krok01]. Also the classical scholar Eric Havelock presented a theory similar to Innis' and McLuhan's in [Have63], published the same year as *The Gutenberg Galaxy,* further developed it later in [Have82] and [Have86], and possibly was the one who inspired Innis in the first place (see [Have86] p. 17). Additionally, the writings of J. C. Carothers, in particular [Caro59], made an important impact on McLuhan. His own most influential works will be *The Gutenberg Galaxy* [McLu62] and *Understanding Media* [McLu94], but of special interest to our present theme is also the posthumous *The Global Village* [MP89]. The pictorial booklets [MF96] and [MF97] most probably contributed more to McLuhan's image as a pop prophet than to his reputation as a scholar. A very readable biography is provided by [Marc98]. Cf. also [Rose69], [Geno98], [Krok01], [Czit82], and [Coyn95a] p. 42 et seqq.

[2224] [McLu94] p. 22 et seqq.

the cartoon, speech, the telephone, and television are "low definition", insofar as they, containing little data and detail, provide but an outline that makes it necessary for the recipient to fill in and "participate" in order to understand, whereas hot media, such as a photograph, a page of print, a lecture, movie pictures, or the radio, being rich in data and detail, extend a single sense in "high definition" and demand little mental participation.[2225]

According to McLuhan, the introduction of phonetic literacy made for a major shift of emphasis between the human senses, "the ratio of the senses", from the original predominance of "acoustic space" in pre-literate, tribal life to that of the "visual space" of literate society, as reflected in the change from primitive, non-representative art to the representative plasticity of, for instance, classical Greek art. Thus, the art of writing was not only a prerequisite for large empires, complex economies based on large-scale trade, the religions of the book, and the systematic pursuit of philosophy and theology, but also changed man's very *modus essendi* in various subtle ways, from tribal man's impulsive, emotional, weakly defined ego to the controlled, goal-oriented, rationalistic individuality of literate man.[2226] Likewise, the Reformation, the centralised national state, the formation of "the public", the modern self-conscious, alienated individuals and groups of individuals, ideologies, mass man[2227], the desacralisation of cosmos, and modern science together with its worldview, specialism, incessant technological change, industrialism, mass production, and market economy would hardly be conceivable without the printing press, which, thus, strongly amplifies the bias inherent already in manuscript literacy.[2228] Interestingly, the cumulativeness of knowledge naturally resulting from the success of the printing press can also be construed as the father of modern-scientific progressivism.[2229]

More recently introduced electric-electronic media, such as the telegraph, the telephone, radio, film, television, and, of course, the networked computer have changed or are about to change man's being once again. But what will the outcome of this shift be? According to McLuhan, electronic media inaugurate the third age of "the global village", an epoch of a "post-literate" second orality, which will give us back the participatory collectivity, a kind of holistic, integral, right brain-hemisphere awareness[2230], and the "buzzing" and chattering audile-tactile space that used to surround the tribal village, but writ large on a global scale, supplanting the predominance of the visual space characteristic of the age of phonetic literacy with its proclivity for linearity, logic, causal reasoning, sequentiality, fragmentation, homogenisation, and left hemisphere mentality. To bring mankind together into "the global village" united by electronics, will thus be the most significant implication of the computerised information networks, which McLuhan – much like de Chardin, besides – viewed as an outering of man's own nervous system.[2231] In the end, McLuhan thus arrives at a tripartite, oddly Joachitic interpretation of history, where the "cool" pre-literate, participatory culture of primitive happiness is followed by the "hot", rationalist literate culture – the temperature being considerably raised by the introduction of the printing press –, which he prophetically pronounces currently to be about to be ensued by the "cool", once again participatory "post-literate" age of electric and electronic media, that is to say the age of the spirit, when man will finally be restored to his primordial happiness.[2232]

2225 The way McLuhan assigned the "hot" and "cool" attributes to different media may seem rather idiosyncratic, as also pointed out by his critics (see, for example, [Geno98] lecture 6). For instance, one may think that television, like movie pictures, should be classified as "hot", but McLuhan asserts that due to the low resolution of television images this medium gives us only outlines, which we will have to supplement in order to make sense of them. Thus, the same film will be "cold", when seen on TV, and "hot", when seen in high resolution at the movie theatre. McLuhan also uses the "hot" and "cold" attributes about people and experiences, for example in order to explain why some "hot", or well-articulated, people, who are very successful on radio, are catastrophes when appearing on television.

2226 See [McLu62] p. 51 et seqq. Cf. also [Have63], [Have82], [Have86], [Snel80], [Brem79], [Dodd70], and [Onia51].

2227 On the concept of "mass man" – the modern, rootless "man without personality", "absorbed by technology and rational abstraction" –, see [Guar98b] p. 57 et seqq. and [Ellu64] p. 405 et seqq.

2228 See [Eise80]. Cf. also [Eamo94] p. 6 et seqq.

2229 So [Eise80] p. 518 et seq. Cf. also [McLu62] p. 124 et seqq. and p. 155 et seqq.

2230 In [MP89], this mode of being is referred to as "robotism", in contrast to the "angelism" of Western literary man, enslaved by the domination of the left hemisphere of his brain.

2231 See [Marc98] p. 216 et seq. Cf. also [Heim93] p. 65 et seqq. and [MP89] p. 103 et seqq.

2232 Peculiarly, McLuhan's historical construction is in some respects remarkably similar to Owen Barfield's theory about the history of man as a progression from the primordial state of "original participation" towards the coming bliss of "final participation", put forth in [Barf88] in the mid-60s, at about the same time as McLuhan published his major works.

McLuhan's writings caused considerable sensation and controversy in the 60s, and his ideas on the significance of media were instrumental in begetting and shaping a new area of scholarly study and conclusively influenced many notable scholars, some of whom were his disciples and some of whom still remain proficient.[2233] Notably, McLuhan's media philosophy wielded an important influence on Alan Kay and his co-workers, when they developed the recipe for the "personal computer" with its user-friendly "graphical user interface" as a kind of personal metamedium or universal simulator.[2234] When McLuhan died in 1980, his ideas were, however, largely out of vogue and he himself had become an *umbra magni nominis.* Only later did his ideas gain a new actuality through the tremendous success of the personal computer and, in particular, the Internet revolution, both of which he had foreseen and subjected to so many brilliant, suggestive, intriguing, and, certainly, frequently questionable analyses.

One of the more curious aspects of the computer age is the fillip the Jesuit Père and palaeontologist Pierre Teilhard de Chardin's dizzying speculations on the *noogenesis,* the evolution of mind, have given to the avant-garde of speculative technoscience.[2235] In Teilhard de Chardin's view, the biological evolution not only implies a trend towards increasing complexity of the life forms and their consciousness, but is a kind of teleological process towards a distinct goal, which he calls the *Omega Point* and holds to be somehow equivalent to Christ, or rather to "the Cosmic Christ", who "by a perennial act of communion and sublimation … aggregates to himself the total psychism of the earth".[2236] Teilhard also claims that the *Omega Point* has been perceived, albeit dimly, in the experiences of mystics and visionaries of all ages. A central part in this evolutionary drama is played by the formation of the *noosphere,* a kind of emergent collective consciousness wrapping the Earth and acting as the cumulative storing-house for the contents of mankind's mental life.[2237] Thus, through the evolution of the *noosphere* and its substructures of social, economic, technological, and informational networks, men's minds are knit together more and more tightly, until the Earth achieves a kind of planetary consciousness itself. At the *Omega Point,* conceived as the ultimate point of convergence, when "God shall be all in all"[2238] and a kind of transubstantiation of the cosmos into the body of Christ, similar to the miracle of the Mass, will be consummated, this supreme consciousness, today only in an early phase of gestation, will, much like Hegel's absolute spirit, arrive at "the illuminating involution of the being upon itself".[2239]

[2233] Some important works influenced by McLuhan's ideas are [Ong88], [Ellu85], [Good87], [Eise80], [IS89], [Turk85], [Turk97], [Meyr85], [Post86], [Post93], [Post94], [John97a], [Heim99], [Kerc97a], [Kerc97b], [Kerc01], and [BG99]. On his influence on the francophone world, see [Geno98]. The speculations in [Moor92] on the new "holistic age" do not to appear to be directly influenced by McLuhan.

[2234] See [Kay90] p. 192 et seqq., where Kay sums up the impact McLuhan made on him thus: "Though much of what McLuhan wrote was obscure and arguable, the sum total to me was a shock that reverberates even now. The computer is a medium! I had always thought of it as a tool, perhaps a vehicle–a much weaker conception. What McLuhan was saying is that if the personal computer is a truly new medium then the very use of it would actually change the thought patterns of an entire civilization. … I named the notebook-sized computer idea the Dynabook to capture McLuhan's metaphor in the silicon to come." And in [Kay84] p. 47, he makes this interesting, distinctly McLuhanesque reflection on the true nature of the computer: "The protean nature of the computer is such that it can act like a machine or like a language to be shaped and exploited. It is a medium that can dynamically simulate the details of any other medium, including media that cannot exist physically. It is not a tool, although it can act like many tools. It is the first metamedium, and as such it has degrees of freedom for representation and expression never before encountered and as yet barely investigated." Cf. also [Kay91] p. 102 et seq., [Kay96] p. 549 and p. 582, [Fren94] p. 14, and [Anon02].

[2235] Teilhard's most influential works will be *The Phenomenon on Man* [Teil65] and the *Future of Man* [Teil69]. Of the huge literature on Teilhard only a few works I have found useful can be mentioned: [Schi81] provides a readable biography and [Luba67a-b] a sympathetic exposition of his ideas, whereas [Lyon82] is crucial for the understanding of the ideohistorical background of Teilhard's system and his notion of the "cosmic Christ". Cf. also [Perk94] p. 279 et seqq. For his influence on computer culture, see [Davi98] p. 289 et seqq., [Heim98] p. 39 et seqq., and [Dery96] p. 45 et seqq. See also [Bitt70] for a discussion of various 'spiritual' varieties of evolutionism, including the theories of Teilhard, Jean Gebser, C. G. Jung, Sri Aurobindo, and tantric Yoga. Additionally, there are some striking correspondences between Teilhard's system and the ideas of Rudolf Steiner, who also attempted to create a kind of spiffed-up, gnostic-evolutionist variety of Christianity, although Steiner's anthroposophy and "Luzifer-Gnosis" were considerably more esoteric-occultist and less scientistic in tenor than Teilhard's noosophy, if we may so denominate it. See [Schi81] vol. I p. 287 et seqq. and [Lyon82] p. 44 et seqq. for some remarks on the palpable influence of esotericism on Teilhard.

[2236] [Teil65] p. 294

[2237] The term "noosphere" was actually coined by the Russian biogeochemist Vladimir Vernadsky, who used it to designate the sphere of thoughts, information, and communication supplementary to the "biosphere" (another term of his).

[2238] This Pauline dictum (from *1 Ep. Cor. 15:28),* often cited by Teilhard, e.g. in [Teil65] on p. 294, was also a favourite of the Romantics. See [Benz83a] p. 49 et seq.

[2239] [Teil65] p. 258

Père Teilhard's theological evolutionism not only attracted the disparagement of the hardcore neo-Darwinists and the understandable misgivings of his own ecclesiastical superiors, who forbade him to publish, teach, and speak on his heterodox ideas and sent him off to China, where he later was to take part in the excavations of the Peking man[2240], but it also became subject to severe criticism from traditionalist Christian and esotericist quarters, to whom his brazen contortion and twisting of Christian spiritual-theological teachings so as to make them fit together with his own inclination for evolutionary modernism are of course odious.[2241] Nevertheless, Teilhard's daring immanentisation of the World Soul and re-interpretation of the notion of the Church as Christ's mystical body *sub specie evolutionis* – largely prefigured by the idealist Romantic speculation, *Naturphilosophie,* giving birth to the evolution theory in the first place[2242] – were instrumental in shaping the new kind of often quite frenzied evolutionist technoreligiosity, which proclaims that a major leap in evolution is imminent, to be brought about, or at least helped, by various technological breakthroughs presently underway, in particular those pertaining to the formation of the technological substructure of the *noosphere,* such as the *Internet,* the *World-Wide Web,* and a virtual reality "cyberspace" to be built on top of these, and the various developments expected to flow from these technologies, such as an "emergent" or "self-organising" "collective intelligence" or "hive mind" of sorts, just to mention some of the watchwords bandied about in this kind of discourse. Such ideas resonate with many scientists and enthusiasts of technoscience, although some – and in particular those of a traditionally tough-minded scientistic-positivistic mindset – find Teilhard's overtly religious-Christian slant of the theme – or, perhaps, his infamous, albeit rather surreptitious, pro-communism – invidious and, thus, avoid citing the Père explicitly. Amongst those following in the footsteps of Teilhard, explicitly or implicitly, we find a disparate omnium gatherum of avant-garde and fringe thinkers, enthusiasts, buffs, and scientists active in areas as diverse as biology, genetics, nanotechnology, cybernetics, systems theory, chaos and complexity theory, artificial intelligence, artificial life, virtual reality, space travel, parapsychology and many other more or less exotic technological and scientific pursuits, to say nothing of various branches of 'pop' philosophy, spirituality and politics.[2243]

Whereas the impact Teilhard's ideas made on McLuhan during the gestation of his most influential books, which saw daylight during the first heyday of Teilhardism, has already been hinted at, the revival of them accompanying the rise of the world-wide web can be seen in much of the rather philosophical-ideological discourse on such topics as collective intelligence, artificial life, cyberspace, and virtual reality.[2244] Notably, the highly influential magazine *Wired* is something of a stronghold of Teilhardism, some of its most prominent columnists, such as Kevin Kelly, Jennifer Cobb, and John Perry Barlow, having been instrumental in popularising Teilhard's ideas through their books and articles.[2245]

[2240] Teilhard had also participated in the excavation of the Piltdown man, which later was exposed as a hoax. Although the accusations directed against Teilhard by various authors, including the late Marxist biologist Stephen Jay Gould, have not been convincingly corroborated, the blot on his escutcheon has not been wholly expunged either. See [Turr98] for an excellent bibliography of the vast literature on this infamous hoax.

[2241] See, for example, [Benz65] or [Sher92] p. 102 et seqq.

[2242] On Teilhard's many predecessors, see [Benz65].

[2243] [Davi98] p. 292 et seqq. briefs Teilhard's influence on the modern mind. Although most neo-Darwinists are hostile or indifferent to Teilhard's ideas, a few, including Julian Huxley and Christian de Duve, have been more appreciating. Teilhard has – together with Vladimir Vernadsky, Henri Bergson, Émile Durkheim, Herbert Spencer, and some other proponents of this or that variety of the organismic notion of collectives – also had a palpable influence on various recent hypotheses of cybernetics and systems, evolutionary, complexity, and chaos theory, and similar attempts at "grand unifying hypotheses", such as James Lovelock's and Lynn Margulis' "Gaia" hypothesis (see [Love91] and [SB91]), Valentin Turchin's theory of a "super-being" and "metasystem transitions"), Gregory Stock's "metaman" (see [Stoc93]), Peter Russell's or Howard Bloom's variants of the "global brain" theme (see [Russ88] and [Bloo00]), Kelly's hive mind (see [Kell94]), George Dyson's "global intelligence" (see [Dyso97]), and Frank Tipler's (and John Barrow's) "Omega Point theory" (see [Tipl95] and [BT96] p. 613 et seqq.). At http://pespmc1.vub.ac.be, the *Principia Cybernetica Web,* various materials on the notion of a "social superorganism", "global brain", and suchlike, building on the ideas of Turchin's metasystem transition theory, can be found. Cf. also [Dert01] p. 79 et seqq.

Some writers on parapsychology and related topics, such as Michael Murphy [Murp92] and Michael Grosso [Gros92], have also speculated on the notion of psi capabilities as somehow foreshadowing a coming evolutionary leap, which supposedly might be conducive to the creation of something like the *noosphere,* whereas other evolutionary inclined parapsychologists, such as Stan Gooch, make *psi* capabilities the hallmark of primitive man (see [Gooc79] and [Gooc84]). Politicians influenced by Teilhard include Al Gore, Mario Cuomo, and Mikhail Gorbachev, who all have spiced their political writings and speeches with talk about the noosphere.

[2244] See [Marc98] p. 216 et seq. At the web site http://www.technoetic.com/noosphere various links to relevant papers are listed. Cf. also [Mizr97].

[2245] See [Kell94], [Kell98c], [Cobb98c], and [Cobb95].

Another famous digeratus having taken his cue from Teilhard is the designer of the virtual reality language *VRML,* Mark Pesce, a "technopagan, goddess-worshipper, ritual magician, and occasional partaker of psychedelic sacraments".[2246] Coupling Teilhard's vision of the *noosphere* to various odds and ends of a more recent extraction, such as complexity theory, nanotechnology, and Rupert Sheldrake's hypothesis of formative causation, he in a number of papers, mostly conference addresses, advocates the idea of a self-aggregating planetary *noosphere,* which, having reached a certain level of complexity, has now turned the complexification inwards and is about to become self-conscious and capable to reflect upon itself, in the same way as, according to Teilhard, man's consciousness is "evolution looking at itself and reflecting upon itself".[2247] His own brainchild *VRML* Pesce holds to be "the porthole cut into the noosphere, the mirror which lets the seer see ourself (sic!)", adding – as a good Crowleyite – the conclusion: "The esoteric promise of cyberspace is of a rule where you do as you will."[2248] The magician's *libido dominandi* will through nanotechnology, virtual reality, and the web extend into all aspects of life, nay, pervade matter itself.[2249] Thus, in Pesce's mind, the Jesuit Père's heretic vision of the transubstantiation of the cosmos into Christ strangely blends with an amplified technoversion of the Satanist Crowley's proclamation of the imminent aeon of Thelema, when you do what you wilt, liberated from all moral or other restraints, "jenseits Gut und Böse".

A particularly outlandish brew involving a variety of Teilhardism as one of its key elements is provided by the physicist Frank Tipler, who in his "Omega Point theory" blends Teilhard's evolutionist ideas with the kind of strong AI speculations and Shannonian pan-informationism mentioned at the outset of this section into a mixture indiscernible from the bravest flights of fancy of the science fiction writers.[2250] Taking for granted that spirit, consciousness, and life can be reduced to 'information', he sets out to show that intelligent life, understood as the computer-based artificial "life forms" that Tipler joyfully envisages will replace the doomed humanity – the sooner the better – will develop to fill and finally enfold the entire Universe, turning "every last atom in the universe into computing machinery"[2251], thereby making it possible to resurrect all humans who have ever lived, when all possible human simulations can be stored in the coming universal computing

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[2246] [Davi98] p. 192. Cf. also [Davi95], [Ples95], and [Slac97]. As a matter of fact, Pesce not only openly professes anarchism as his political standpoint, sodomy as his sexual orientation, and witchcraft as his religion – having, for example, through magic rites attempted to infuse "a godform … named Hermes" into cyberspace –, but regards himself an acolyte of the infamous occultist Aleister Crowley, once dubbed "the wickedest man in the world" by the popular press.

Aleister Crowley (1875-1947), the notorious claimant of the title "the Beast 666", was the self-styled spokesman of the purported astral being "Aiwass", whom he, additionally, identified both with the Sumerian demon Shaitan (a.k.a. as Satan) as well as with the Egyptian devil-god Set, once worshipped by one of the most decadent Gnostic groups, the Sethians. On account of "Aiwass", he proclaimed in his *Book of the Law* the new "law of Thelema", "Do what thou wilt", although this "law" was not new, but appropriated from Rabelais and, in addition, traceable as far back as to the ancient Gnostics, unto whom Simon Magus imposed it as a duty (see [Rudo94] p. 264). Crowley also entertained his own variant of the Joachitic tripartition of history, compartmentalising it into the three aeons of Paganism, Christianity, and Thelema, dominated by the Mother/Isis, the Father/Osiris, and the Child/Horus, respectively. He professed to be the prophet of the imminent aeon of Horus, of whom he even came to consider himself an incarnation and wrote thus: "Everywhere his go-vernment is taking root. Observe for yourselves the decay of the sense of sin, the growth of innocence and irresponsibility, … the childlike confidence in progress combined with nightmare fear of catastrophe." (cited from [Gran74] p. 71; cf. also [Viri00] p. 93 et seqq.). As noted by [Jone94] p. 161 et seqq., Crowley's philosophy – together with its moral implications of uninhibited debauchery, drug addiction, the violation of all taboos, the darkest possible forms of occult and magical rites, total callousness towards others, and the endorsement and praise of lunacy and madness – appears largely to be a somewhat vulgarised, occultist version of Nietzsche's nihilistic attack on Christianity and morality in general. Although Crowley boasted of having committed thousands of human sacrifices, and he himself, his Masonic-like organisation *Ordo Templi Orientis* (see [Arle96] p. 204 et seqq. and [AW01] p. 181 et seqq.), and its various offshoots have often been suspected of being implicated in ritual abuse and murder, no conclusive evidence in favour of these dark suspicions seems ever to have been produced (see [NP00] p. 138 et seqq.). The counterculture, when it all of a sudden descended upon the Western world in the late 60s, brought the teachings of Crowley and other like-minded occultists into the limelight again – on its complex roots in the occult, progressive underground of the 19th and early 20th century, see [Webb90] (which is a revised version of [Webb71]), [Webb76], [Gree86], [Scha90] p. 96 et seqq., [Jone93], [Jone94], [Jone95a], and [Morr92]. Cf. also [Ekst90].

[2247] See [Pesc95b], [Pesc96b], and [Pesc97b-d]. The *noosphere* is also alluded to in many other of the talks, papers, interviews, and 'rituals' available at Pesce's homepage http://www.hyperreal.org/~mpesce.

[2248] [Pesc97b]

[2249] See [Pesc00], a kind of manifesto of technomagic. Cf. also [Pesc99a].

[2250] See [Tipl95] and [BT96] p. 613 et seqq. Tipler's theories are also partly supported by David Deutsch, the inventor of the "quantum computer", in [Deut98] (see p. 347 et seqq. et passim). These speculations as well as others of the same ilk are competently scrutinised and criticised in [Midg94] (see, in particular, p. 147 et seqq. for the Omega Point theory).

[2251] [Tipl00]

supermind of the *Omega Point,* which he undauntedly equates with God.[2252] Through these and other similar verbal conjuring tricks, Tipler claims he has proved the existence of "God" and the resurrection of the dead and provided a new, inspiring interpretation of old religious tidings. Unsurprisingly, Tipler's seriousness has been doubted by many critics.

Many of the aforementioned themes are drawn together in a peculiarly outré form by the extremely technooptimistic "extropian" or "transhumanist" outcropping of the gnostic subculture of California, a quasi-religious movement based on a salmagundi of Nietzschean ideas about the coming of the *Übermensch* – now revamped as *Omega Man* – blended with flotsam and jetsam from liberation and transformative psychology, from various health cults, particularly those promising a longevity far beyond a normal human life span, from Ayn Rand's egotistic-libertarian philosophy of "objectivism" and kindred anarcholiberal political agendas, from hardcore neo-Darwinism of the ruffianly Dawkinian gene-machine/memetics variety, from the naïve casehardened naturalism of cognitive science and complexity theory, from various speculations about the extension of man's capabilities through "implants" and "cyborg" technology[2253], from Hans Moravec's, Ed Fredkin's, Frank Tipler's, and some others' beyond-the-pale versions of the programme of strong AI, and from flabbergasting and upbeat science fiction-inspired speculations on the future of technoscience welded together by a most unremitting pop technoduly and scientism.[2254] The extropians, whose designation derives from their advocacy of "extropy," a principle supposedly combating entropy and the second law of thermodynamics in the cosmos, are perhaps best known for their enthusiasm for the strange fad of cryogenics, i.e. the freezing of human corpses – or in case of penury, just the head – so as to make it possible to revive them or, at least, tap the mind from the frozen brain of the departed, as soon as science has made such feats possible. Apart from cryogenics, the extropians are also notorious for their curious futuristic visions concerning the colonisation of space, robotics, artificial intelligence, body implants, genetic engineering, smart drugs, nanotechnology, the "post-Darwinian" or "post-biological" evolution amongst self-replicating machines, and, in particular, the use of nanotechnology for adding computers and other new facilities to the brain and the human body, for repairing malfunctioning parts of the body, and, ultimately, for reading off the mind from the brain and upload it in a computer, so as to make it possible for man to scrap this mortal coil altogether and, having become "posthuman", travel through (cyber)space as pure information, taking on, through the reliance on nanotechnology, a tailor-made robot body whenever a desire or need for embodiment arises, and much other such silly nonsense. The extropians have a few well-known scientists amongst their backers, such as the AI luminaries Marvin Minsky and Ray Kurzweil, who are both on the board of advisors of the *Extropy Institute,* but ideas and visions kindred to the juvenile extropian fantasies have a much wider audience and popularity than the small extropian sect, especially within the research fields, in which the extropians delight.[2255]

The crucial rôle accorded to nanotechnology is a recurrent theme in many of the speculations we have discussed above. The field of nanotechnology was initiated at the AI lab of MIT in the mid-70s by K. Eric Drexler with the support of Marvin Minsky, although the seminal ideas had been put forward in a lecture already in 1959 by the physicist and Nobel-prize winner Richard Feynman. Nanotechnology is a direction of research bridging areas such as chemistry, materials science, biomedicine and "molecular electronics", aiming at the construction of small molecular machines and robots – often called nanomachines, or nanites, and nanobots, respectively – by arranging the individual atoms and molecules one by one.[2256] To achieve this,

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[2252] This idea seems akin to the Russian 19th century philosopher N. F. Fedorov's suggestion that science should work towards the goal of reconstituting all dead who have ever lived. See [Heim93] p. 118 et seqq. [Midg94] p. 148 et seqq. also discusses the notion of *Omega Man* hypothesised by some Omega Point aficionados.

[2253] Cf. [Gray95]. The term cyborg, an abbreviation of "cybernetic organism", denotes a human person enhanced by digital equipment directly connected to his body.

[2254] See [Davi98] p. 117 et seqq., [Dery96] p. 301 et seqq. et passim, [Regi90], [Goda95], [Alex00], [Hayl99], and [More01], a kind of extropian manifesto. Cf. also http://www.extropy.org, the web site of the *Extropy Institute,* lead by Max More, the chief propagandist of extropianism, and http://www.aleph.se, the web site of *Svenska Transhumanistförbundet,* the Swedish branch of this movement. There are also striking similarities between the extropian ideology and the "pentagonal revisionism" advocated by Anton LaVey, the infamous founder of "the Church of Satan", another anti-Christian atheistic-materialistic sect made in California promoting ruthless egoism, social Darwinism, nihilism, and hedonism (see [AW01] p. 197).

[2255] See, for example, [Kaku97] and the ***non plus ultra*** of posthuman extremism [PC96], a bulky effusion of frenzied technomania and puerile hatred of religion – fittingly entitled *Beyond Humanity* and dedicated to *ENIAC* –, co-authored by an "evolutionary biologist" and an "international authority on the applications of artificial intelligence".

[2256] See [Drex86], [Cran96], and [Regi95]. In the more Corybantic speculations, the borderline between nanotechnology and other exotic fields, such as artificial life, Dawkinian memetics, and quantum computing, often becomes very fuzzy.

nanoscientists attempt to construct a "nanocomputer", a kind of miniature processor capable of executing simple instructions. The next step after the nanocomputer will be the "nanoassembler", which supposedly will make it possible to assemble atoms into macromolecular structures, somewhat similarly to the way proteins are made in the living cell. Amongst the possible boons the devotees of this burgeoning field hold out are the production of multifarious commodities, such as, for example, artificial food or new medicines, from raw materials abundant in nature or even from garbage, the invention of new materials with all kinds of interesting properties, a wide range of biomedical applications, including the cure for cancer, and the great crock of gold at the end of the rainbow containing the secret of how to repair the cells of the human body so as to keep it alive and vigorous for ever.[2257] Nanotechnology is still in a very early phase of gestation and viewed with great distrust by some critics, but is wrapped up in a cloud of grand expectations, exuberant speculations, and nightmarish fears.

Also less frenzied interpretations of history than those related above, untarnished by the empyrean flights of speculative Teilhardism and nanofantasy, tend to hail the computer as the inaugurator of a new cornucopian age, not uncommonly falling back on some kind of tripartite, Joachitic-like construction of history. So Alvin and Heidi Toffler already back in the 60s famously partitioned history into three waves, the first of which brought forth the agricultural society and the second the industrial society, whereas the third is now about to establish the information society.[2258] A similar model of history is implicit in the works of Peter Drucker, who also in the 60s foresaw the arrival of the "knowledge economy", where "knowledge workers" replace the "production workers" of yore, and more lately has proclaimed the arrival of the "post-capitalist" "knowledge society".[2259] Likewise, Jay David Bolter regards the computer as a "defining technology", which plays the same rôle in moulding the ideas and world views of our age as the craftsman, the mechanical clock, and the steam engine paradigm played during earlier epochs.[2260]

The larger part of these brave new Omega worlds[2261] alacritously promulgated as the new Jerusalem of technoscience by their devotees will probably strike most independent observers as neither very believable, nor to be gleefully cheered – rather they are likely to be greeted as the silly and nefarious ravings of the archetypal mad scientist. Indeed, there is no want for critics of these and other kindred utopias, nor for thinkers interpreting the future technoscience will provide mankind with in the most sinister "technocalyptical" terms.[2262] McLuhan, for one, recognised that every new technology not only provides benefits to man, but also implies a loss, as the balance between the human senses is implicitly changed by the new technology.[2263] In his darker moments, he likened the "electric information environments" about to form not to a "global village" of universal harmony, but to a "facsimile of the mystical body, a blatant manifestation of the Antichrist."[2264] During the 70s he developed the idea of "discarnate man", who, liberated from the physical

[2257] Cf. also [Schn98] for a survey of some other research fields, where this crock is also chased.

[2258] See [Toff71], [Toff81], and [TT95]. Cf. also [Webs95b].

[2259] See [Druc68] and [Druc93].

[2260] [Bolt84a]. Cf. also [Talb95] p. 31, where an observation by Owen Barfield quite similar to Bolter's thesis is cited. On the question of "technological determinism", see [SM94] and [Hill88].

[2261] There are indeed other varieties of the brave new world of computing, including Gelernter's "mirror worlds", which provoked the UNA bomber to send him one of his explosive letters, and the late Mark Weiser's "ubiquitous computing". See [Gele91] (subtitled "the day software puts the universe in a shoebox"!) and [Weis91].

[2262] See [Davi98] p. 253 et seqq. and p. 305 et seqq. for some examples. The ideas of several of these technopessimists will be treated at greater detail below.

[2263] He even attempted to create a kind of quasi-formal framework for understanding these changes through his "tetrad", which is a scheme of four questions (see [MP89] p. 9):

1. What does any artefact enlarge or enhance?
2. What does it erode or obsolesce?
3. What does it retrieve that had been earlier obsolesced?
4. What does it reverse or flip into when pushed to the limits of its potential (chiasmus)?

For example, the computer will, according to McLuhan (and his co-writer Bruce Powers), 1) accelerate logic sequential calculations to the speed of light 2) erode or bypass mechanical processes and human logic in all sequential operations 3) highlight "numbers is all" philosophy and reduce numbering to body count by touch 4) flip into the simultaneous from the sequential and accentuate acoustic over visual space to produce pattern recognition (id. op. p. 176 et seq.).

[2264] Quoted from [Davi98] p. 254. Cf. also [Lang00] p. 131 footnote 10.

limitations of corporeality through various electronic equipment, no longer identifies his self with his body, but with a shadowy, gnostic pattern of information and, swamped by the deluge of incoming information and images, tends to live in a hypnotic state between fantasy and reality, where he will suffer a breakdown between his consciousness and his unconscious and, having lost identity, civility, literacy, discipline, purpose in life, and the sense of natural law, will become a brute prone to acts of violence and crude amorality.[2265] Indeed, the further development of electronic media and their sway over young people after McLuhan made his lurid predictions about "discarnate man" has hardly proved his prophecy wrong.

Nor is the dystopian antipode of the maniacal progressivism of the technodules limited to the discontented outsiders to computing, as can be seen from the popularity of the pungently nihilistic-pessimistic 'cyberpunk' literature, such as Gibson's and Stephenson's writings, which have made a noticeable impact on the discourse and development of the fields of virtual reality and cyberspace.[2266] The great bogeyman of nano-research, frequently discussed also by the scientists into the game, is the nanoassembler turning Turk, possibly rendering the entire biosphere of the Earth into a self-replicating "grey goo" or "grey dust" in a short time.[2267] There are in fact a great number of such horror scenarios – naturally often blurring the division line between nanotechnology proper and genetic engineering – contemplated in the literature, where a little laboratory accident leads to the invasion of the biosphere by nano-modified or genetically engineered vira, bacteria, inedible plants, or the like, which in the end displace all current life-forms. Recently, the computer luminary Bill Joy's apprehensions – partly inspired by the UNA bomber Theodor Kaczinsky's technocritical manifesto – about the current developments in artificial intelligence (as envisioned by the strong AI energumens), robotics, genetic engineering, cloning, nanotechnology, and weapon technology and the hazards of the self-replicating processes involved getting out of hand received much attention in the computer press.[2268] For now, I will, however, postpone the discussion of the technocalyptic view of computing, which, however, we will come back to at somewhat greater length in the final sections of this study.

When contemplating these unruly, posthuman, postbiological, extropian, etc. agendas hatched at some of the most prestigious research institutes in the world, one is inevitably struck by the oddity of so many well-educated and gifted, in some cases even brilliantly so, researchers' indulging in these facile and fatuous speculations, thereby lending weight to the age-old observation that intelligence is not necessarily the same thing as wisdom or insight and to Chesterton's famous quip that when man ceases to believe in God, he will believe in anything. Theirs is the gnostic magician's dark, sad worldview, largely built of preposterously distorted, immanentised flotsam and jetsam from classical occultism and the realms of authentic religion and spirituality, a gloomy conception of the world and man as a game of shadows, which can be studied, experimented on, manipulated, blown up, and put in a box, but is destitute of grace, meaning, substance, love, respect, and hope – except in perverted, metaphorical senses arrived at through intellectual legerdemain and deconstructions.[2269] Once again, we can see the usefulness of the categories Voegelin and McKnight have

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[2265] [Marc98] p. 248 et seqq. Somewhat similar reflections were made in [Ellu85].

[2266] See above p. 270.

[2267] This discussion began already in [Drex86] p. 171 et seqq., i.e. in the work, which gave birth to the field in the first place.

[2268] See [Joy00].

[2269] The poverty of this worldview is also evinced by the striking similarities between some of its most cherished elements, such as Marvin Minsky's theory of the "society of mind" (see [Mins88]) and Richard Dawkins' concept of "memes" (see [Dawk78] p. 206 et seqq.) and various key concepts ("body thetans", "dianetic demons", "engrams", "implants") in the teachings of the strange pseudo-religious cult known as scientology, concocted in the early 50s from various odds and ends garnered from psychoanalysis, psychiatry, cybernetics, biology, occultism, etc. by the eccentric, Crowleyite occultist and science fiction writer L. Ron Hubbard (see [Mill88], [Cory92], [Atta90], [Atta_a], and various scientology-critical web sites, such as http://www.factnet.org/index.html, http://www.b-org.demon.nl/index.html, http://www.xenu.net, and http://www.cs.cmu.edu/~dst/NOTs). The aforementioned psychological notions of Hubbard's were popularised and became something of a commonplace in science fiction literature (e.g. in Philip K. Dick's influential neo-gnostic writings and in the nihilistic cyberpunk novels), largely through the extensive use made of the concept "word virus" in the writings of the beat author William S. Burroughs, who, apart from being a follower of Hubbard, also was a drug addict, convicted criminal, and perpetrator of multifarious depraved exploits, including the killing of his common-law wife. See [Kahn95], where some of Hubbard's sources for these ideas are also traced, such as notably the German biologist Richard Semon, who coined the two terms "mneme" and "engram" and will, as suggested in [Laur99], be the ultimate source also of Dawkins' "memes". Cf. also [Atta_b], [Hans01a], [Kull99], [Jaki89] p. 96 et seqq., and [Davi98] p. 282.

Granted that it *prima facie* seems unlikely that ideas from scientology should have made a direct impact on scientists such as Dawkins and Minsky – although science fiction literature, which has provided so many links between occultism and science and is avidly read be many scientists, including, for one, Minsky, may indeed have provided an indirect connection (see [Webb76] p. 496 et seqq. and [Bran87] p. 224 et seqq.; cf. also id. op. p. 107 for some remarkably scientology-like reflections by Minsky) –, there is nevertheless a strong family likeness

provided us with for understanding and coming to terms with such disorientation and pneumopathology. And, after all, proper diagnosis must always precede any attempt at a cure.

Leaning on the conceptual machinery developed by Voegelin and his disciples, we can descry how the gnostic-apocalyptic thought structures fomenting the immanentisation of the eschaton have staged the play according to the same old dramaturgy we have seen so many times before in this study:[2270] Here are the sense of gnostic alienation in the world – the boring *RL (Real Life)* of the cyberpunk novels –, the disgust with the 'meat' – as the body is referred to in cyberpunk lingo –, the craving for thrills and experiences out of the ordinary, the consequent turn away from the Ground of this world to an idol, which in this case is techno-science, the hope for innerworldly liberation and fulfilment through this idol, the obsession with power and the dominion of man over being so as to bring about the new utopian, posthuman age, now through nano-technology, virtual reality, artificial intelligence, artificial life, robotics, cyborg technology, etc., an absolute belief in a constructed secondary reality – propped up by the usual sophistic-rhetorical skullduggery – together with a concomitant gnostic mythology, which legitimises and makes credible the *per se* wholly unrealistic claims and promises, and the formation of Hermetic-prophetic brotherhoods of gnostic scientists who will help into being the new age, which, of course, will involve the usual break with all previous history through a coming breakthrough, which in this case some insiders refer to as "the singularity". Certainly, there is also in the discourse of these techgnostics, whose claims seem so fantastic and whimsical that few outsiders would take them as serious expressions of opinion, a strong element of (self-)deception, which tends to turn into diabolical mendacity and refusal to consider counter-evidence, as soon as the errors in the cherished compages are pointed out to them.

The vortex of dumbfounding ideas, concepts, and theories rotating at an evermore maddening pace around the surfers of this intellectual maelstrom has long since made reality vanish entirely out of sight to them, quelling through its cascades of dazzling visionary-utopian rodomontade the open quest for the truth about reality and its divine Ground, who must not even be mentioned lest peradventure the construction should collapse, except perhaps as a joking jest or in some incantatory metaphoric sense that will strengthen rather than jeopardise the status and self-esteem of the brotherhood of the coming posthuman age. The same mad logic of gnostic immanentism that brought forth the other secular religions, which, whether conjured up by the Encyclopedists, Hegel, Comte, Marx, Freud, Nietzsche, Darwin, Crowley, or someone else of their gnostic ilk, have repeatedly exhibited such a hideous proclivity for destruction and wickedness, is also operative here. If ideas have consequences – and, indeed, our age has witnessed appalling catastrophes emerging from the intellectual divertissements of all the aforementioned gnostic scryers and jugglers –, we may well wonder in what cesspool of terrors the mad dreams of today's gnostic scientists may eventually debouch. If all gnostics share a fundamental hatred of reality and existence, the gnostics of old on the main by necessity had to confine their attacks to the devastation of man and human society, whereas the present-day techgnostics differ insofar as they threaten to extend the assault to the biosphere in its entirety, nay, at least in their wildest fantasies, to being itself.[2271]

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between scientology and the kind of free-wheeling scientific speculation reviewed above, a fundamental affinity in outlook and climate of opinion perceptible in the general gnostic-cybernetic tackiness, the contorted adaptation of spiritual themes, the air of unsound affliction, the lack of genuine depth, and the thoroughgoing cynicism common to both, as reflected also in their striking conceptual similarities. Or, to put it somewhat more bluntly, Dawkins' "memes", Minsky's "agents" and "society of mind", Burroughs' "word virus" and "pre-recordings", and Hubbard's "body thetans", "dianetic demons", and "implants" all look strikingly like immanentisations of the age-old notion of demonic possession. The ulterior motive behind all these immanentised concepts also appears to be much the same, viz. their authors' venomous, Luciferian hatred against Christianity and religion in general and the classical Christian-Platonic conception of the soul in particular, which, thus, they set out to deconstruct armed with these craftily constructed conceptual warheads. So Dawkins' first example of a "meme" in *The Selfish Gene* is God, and Hubbard made Christ an "implant". But the real confidence men in this game, busily attempting to construct "memes" and "implants", are of course Dawkins, Hubbard, and their ilk themselves, who by playing such puerile tricks with language try to becloud reality, shortcut man's search and longing for the truth about reality and its Ground, inveigle the unsuspecting into their own cynical and highly dubious, not to say pernicious and revolting, belief systems, largely through verbal intimidation, and earn some money in the bargain. The *non plus ultra* in meme silliness will be [Blac99], written by a woman parapsychologist, notorious in parapsychological circles for having gone through a quasi-religious conversion to *CSCICOP* skepticism much advertised by herself. Cf. also [Hayl01], who, in the awkward lingo of postmodernist literary theory, interprets Dawkins' and others' "dislocation of agency and marginalizing of consciousness" as "typical characteristics of the posthuman".

[2270] See above p. 339.

[2271] Cf. [Slou95], who construes the current wave of cyberextremism as a fourfold assault, on identity, place, community, and reality.

The prophet Jeremiah busied himself alone with the Book Yetsirah. Then a heavenly voice went forth and said: Take a companion. He went to his son Sira, and they studied the book for three years. Afterward they set about combining the alphabets in accordance with the Kabbalistic principles of combination, grouping, and word formation, and a man was created to them, on whose forehead stood the letters YHWH Elohim Emeth.[2272] *But this newly created man had a knife in his hand, with which he erased the aleph from emeth; there remained: meth. Then Jeremiah rent his garments [because of the blasphemy: God is dead, now implied in the inscription] and said: Why have you erased the aleph from emeth? He replied: I will tell you a parable. An architect built many houses, cities, and squares, but no one could copy his art and compete with him in knowledge and skill until two men persuaded him. Then he taught them the secret of his art, and they knew how to do everything in the right way. When they had learned his secret and his abilities, they began to anger him with words. Finally, they broke with him and became architects like him, except that what he charged a thaler for, they did for six groats. When people noticed this, they ceased to honor the artist and came to them and honored them and gave them commissions when they required to have something built. So God has made you in His image and in His shape and form. But now that you have created a man like Him, people will say: There is no God in the world beside these two! Then Jeremiah said: What solution is there? He said: Write the alphabets backward on the earth you have strewn with intense concentration. Only do not meditate in the sense of building up, but the other way around. So they did, and the man became dust and ashes before their eyes. Then Jeremiah said: Truly, one should study these things only in order to know the power and omnipotence of the Creator of this world, but not in order really to practice them.*

Pseudo-Judah ben Bathyra (early 13th century)[2273]

Cyberspace is Platonism as a working product.

Michael Heim[2274]

I som ropen: "Det är ingen,
ingen själ fördold i tingen,
allt är stoft, ej mer";
dårar! blott till källan stigen,
sen ert anlete och tigen,
rodnen, höljen er!

Frans Michaël Franzén (from the poem "Menniskans anlete")[2275]

The construction of the electronic computer was essentially a metaphysical project from the start, an attempt to create an "electronic brain", the Golem that would confirm the materialist and atheist presuppositions of its own creators, or to put it bluntly, prove God dead, the scientists the sole gods of Earth, and science the only true religion.[2276] Ever since, the computer has been widely used for making metaphysical points of different kinds. Indeed, already Charles Babbage, in his Bridgewater treatise, used his own calculating engine as a basis for metaphysical arguments. For example, in order to support the view that miracles are not "deviations from the laws assigned by the Almighty for the government of matter and of mind", but "the exact fulfilment of much more extensive laws than those we suppose to exist", he showed how he could control the usual regular, law-like operations of his engine so there would be *"seeming* exceptions to that

[2272] 'God is truth'.

[2273] Quoted from [Scho96] p. 180 et seq. Cf. also [Wals92] p. 164.

[2274] [Heim93] p. 88

[2275] [Fran1895] p. 6 (originally published in Stockholms-Posten, no. 214, 1793).

[2276] This preposterous programme provides the subtext of much of the written output of the fathers of computing, being particularly conspicuous in the frequent, often glibly cynical tongue-in-cheek allusions to religious themes they so amply interspersed in their books and papers. See, for example, [Turi50], [McCu65], [Wien64c] p. 116 et seqq. and p. 169 et seqq., [Wien64a], [Wien94] p. 121 et seqq., [Neum45], and [Neum58].

law".[2277] Thus, Babbage, like so many others following suit up to the present day, thought he was able to play God and understand God's ways through the machine by making the computer an instrument for metaphysical thought experiments.

Clearly metaphysics is crucial if we want to evaluate the feasibility of such Faustian endeavours as those described in the previous section. In fact, the so-called strong programmes of *artificial intelligence (AI)* and *artificial life (AL),* which assume that *real* intelligence and *real* life – including consciousness – can be created in a computer, only make sense within one kind of metaphysics, to wit Poortman's *Alpha* standpoint. But even from a naturalistic point of view, some of the assumptions of these agendas – for example, that consciousness can be engendered by an electronic machine, that (some) snippets of programme code executing on a machine can be regarded as a kind of "life", that thinking is "information processing", "symbol manipulation", or "computation", or that mind, consciousness, and life are in some sense equivalent to information that can be binary encoded – will be extremely moot.[2278] In all standpoints of Poortman' scheme other than the *Alpha* one *(Beta-Zeta)*, the claims of strong AI and strong AL are simply nonsensical. So what conclusions can be drawn about the realism of these agendas from more than 50 years of computer science and artificial intelligence research? Are there any hard facts that lend support to their materialist presuppositions?

Anyone who has looked into the workings of the different types of AI programmes knows that, for all their ingenuity and interesting capabilities, they are beyond peradventure of a doubt nothing but *simulations* of *bona fide* intelligence, encoding the knowledge of a skilled programmer, at times supplemented by some preprogrammed mechanism for accumulating further information.[2279] So, a chess programme may outwit even a very skilled chess player by drawing on the brute calculation and search force of a powerful computer, an *Eliza*-styled interlocutor programme may mimic simplistic conversations through simple pattern matching, and a neural network can be used to make a computer 'learn' how to 'recognise' the characters of a certain type of fount, but these and other seemingly intelligent behaviours of computer programmes are in fact only programmed *simulations* of intelligence and not the real thing.[2280] A child can tell that there is really no one there inside the computer and that anyone, who talks about how the computer will 'awaken', as raw computing power evolves, has – in more than one sense – lost his mind. As a matter of fact, there is absolutely nothing that lends the least support to the allegation that skilful programming together with a lot of computing power would be capable to engender consciousness or life. Nor is it easy to understand how the rapid growth of the *Internet* can, by anyone in his right senses, be construed to imply that a man-made *World Soul* or *noosphere* is now about to become self-conscious. The fallacy common to both these speculations is the

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[2277] [Babb89a] p. 29 et seqq. The importance Babbage attached to this deistic argument is testified to by the fact that a separate chapter is dedicated to it also in his autobiography [Babb89b] p. 290 et seqq. Cf. also [Cann60].

[2278] See, for example, [Denn98] p. 215 et seqq. The strong agendas of AI and AL are often combined with a "functionalist" or "eliminative" interpretation of mind. In the former, the mind and consciousness are construed as "functions" of the brain, supposedly related to it in a way similar to how an executing computer programme is related to a computer, whereas according to the eliminative view there is, *mirabile dictu,* no mind or consciousness at all, these instead being dismissed as illegitimate concepts of "folk psychology". These rather absurd theories have recently come under heavy fire from within the scientistic-materialistic camp itself, being criticised by, for example, Searle, Penrose, and McGinn (see [Sear92], [Penr91] [Penr97], and [McGi99]; cf. also [Bode90]). But despite the subtlety of some of their arguments, these philosophers of mind in the end betray themselves as just as dogmatic and mindless in their relentless biologism and physicalism as those they criticise, as borne out by their self-imposed refusal to even take into consideration the paranormal and mystical phenomena evidently so highly relevant to the issues at hand, by their blind faith in scientific materialism and atheism and the neo-Darwinist and other similar scientistic mythology, and by their total indifference to, or contempt for, the life of the spirit and religious-theological perspectives. But what gain is there in bulky studies, which do not even touch the phenomena most relevant to the subject supposedly studied, but instead are packed with long-winded logomachies concerning Chinese rooms, smart zombies, Mandelbrot sets, Schrödinger's cat, black holes, and other voguish, but largely irrelevant topics? And what is the probability that anyone, who dogmatically espouses presuppositions that are demonstrably false, will from these very erroneous premises arrive at anything even faintly similar to the truth of the matter?

[2279] Much of the confusion surrounding artificial intelligence has its roots in the rather insipid so-called Turing test, proposed by Alan Turing in [Turi50], which somewhat furtively suggests that if a computer simulation of intelligent behaviour is convincing to an independent observer, the machine really thinks, which, of course, is a perverse argument.

[2280] Turing in fact recognised that the idea of thinking machines was a chimera, as is obvious not only from his comments on extra-sensory perception in [Turi50], but also from some of the other arguments he makes there, such as his facile scoffing at "the theological objection", which he does away with in the utterly unconvincing, self-deceiving manner typical of the positivists, who were in the habit of abolishing the wisdom of the ages and 'resolving' the deepest enigmas of existence through some little nihilistic sophism, phrases of high-brow-sounding fee-faw-fum, fantastic misrepresentations, and one or two cynical paradoxes. Despite his own insight about the futility of his argument, Turing chose to support the idea of the "imitation game" as a criterion of real intelligence, most likely because it seemed to bolster the anti-Christian and anti-religious sentiments he rather undisguisedly gives expression to in his paper.

reduction of spirit to what it patently is not, viz. binary encoded information executable on a computer processor. On the contrary, such information and such processors are themselves *de facto* the expressions of the spiritual life of man. What all these wild speculations do illustrate, is, however, the modern compulsion to immanentise spiritual concepts, such as, in this case, the soul of man and the world soul, respectively.[2281] Arguably, all this hysterical talk about the downloading of human souls into computers, the emergence of consciousness during the execution of computer programmes, and the evolution of "artificial life" through programming in itself constitutes an excellent *reductio ad absurdum* of the murky naturalistic and Darwinist presuppositions of modern science, demonstrating how the gnostic-scientistic flight from reality, the conscious negligence of fundamental facts of human existence, such as those discussed above in the section on the vacuity of naturalism[2282], and the construction of secondary dream realities upon nebulous, but belligerently defended foundations, by necessity lead the brotherhood of scientific *perfecti* deeper and deeper astray into an inextricable thicket of illusion, self-delusion, and feverish pipe-dreams.

In fact, references to computers and computer software abound in the quarrels over evolutionary biology. We have already commented on the claims of the strong programme of artificial life research and how these are rooted in naturalist metaphysics and Darwinist beliefs about the evolution of life.[2283] But not only is the naturalist-Darwinist standpoint untenable in itself, as we have argued so many times now, but the experiences accumulated over the years from the field of software construction also provide formidable counter-evidence against the claims of Darwinism and naturalist philosophy by highlighting the extreme fragility of complex cybernetic systems, the tremendous difficulties often involved in building them, and the absolute need for careful *intelligent design* in order to get such systems up and running. In fact, absolutely no credible support can be mustered from the fields of computing and engineering for the Darwinist allegations, put forth by the neo-Darwinian propagandists and their numerous allies amongst the cohorts of atheist-materialist philosophers, that Archdeacon Paley's famous watchmaker can be replaced by undirected random processes, the "blind watchmaker" of Richard Dawkins' overheated imagination.[2284] From the point of view of computing, cybernetics, information theory, and, indeed, all engineering activities, the Darwinist claims about the aleatory self-organisation of the extraordinarily complex systems that constitute the subject-matter of the biological and biochemical disciplines of science appear as nothing but fantastic and vacuous fairy-tales.[2285]

Let us now take leave of *artificial intelligence* and *artificial life* research and instead ask what the metaphysical implications of the fields of *virtual reality* and *cyberspace* are. Although there are various authors, who have written on virtual reality from a philosophical-metaphysical point of view, very few of these authors really use it to make metaphysical points.[2286] *Prima facie,* it would seem plausible that virtual reality could be used to underpin some kind of dualist metaphysics. A virtual world is composed by a designer-programmer, who appears to take on a rôle similar to that of the Platonic Demiurge, who, taking advantage of various pre-existent *ideas,* determines the structure of the created world, whereas the partaker of this world makes his entrance through an 'avatar', a mock-up body used as the vehicle of his own irreducible conscious self, his spirit, in an arguably quite Platonic way. In Poortman's scheme, this set-up would qualify as reminiscent of the *Epsilon* standpoint (dualism), or perhaps rather the *Delta* standpoint, if we somewhat awkwardly regard our material body as a kind of fine-material 'astral body' that constitutes the interface to the avatar that is our 'real' body in the virtual world.[2287] Arguably, it would also be possible to interpret the virtual experience in terms of the *Beta* and, albeit somewhat ineptly, the *Gamma* standpoints, if we regard the mental life of the persons behind the avatars as 'fine-material', as, for instance, a Buddhist would perhaps be inclined to do. In any case,

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[2281] The claims of the strong programme of AI have been animadverted on repeatedly over the years. Engelbart's view of the computer as a *tool* for *intelligence amplification (IA)* and Kay's idea about it as a *metamedium,* giving birth to the personal computer, were largely framed in opposition and reaction to the AI agenda. Many more or less extensive critiques of AI and, in particular, its strong programme and its presuppositions have been put together over the years, such as notably [Weiz76], [Bolt84a], [DD86], [Barr86], [WF87], [Jaki89], [Drey92] and [Ekda97]. Cf. also [Nobl99] p. 143 et seqq. and [Demb99a] p. 216 et seqq.

[2282] See p. 322 et seqq.

[2283] See footnote 2215 on p. 484 for some references.

[2284] [Dawk86]

[2285] This has been pointed out by many authors, such as, for example, [MK85], [Wild81], [ReMi93], [Spet98], [Gitt00], [John99b], and [Milt97] p. 167 et seqq. and p. 223 et seqq.

[2286] Cf. above p. 272.

[2287] To confuse matters further, virtual worlds *per se* exhibit many similarities to astral worlds. Cf. [Davi95].

the materialist *Alpha* standpoint seems entirely out of place here, as the participants of a virtual world and their experiences and reactions to this world cannot be reduced to the 'noetic matter' from which the virtual world itself is built. Nor will the idealist *Zeta* standpoint be very useful here, as the simulated 'matter' of the virtual world, albeit as illusory as the veil of Maya, can in no wise be reduced to spirit.

Nevertheless, it is often assumed that virtual reality would lend support to some kind of idealism, or even to acosmism. The reasoning behind this suggestion is of course that the virtual world, being a kind of artificially produced illusion or simulation, seems to suggest that the usual world of our senses may also be some kind of deception or construction, akin to the veil of Maya of Vedanta. Such ideas have always enjoyed widespread popularity in philosophical and religious speculation. For instance, in most varieties of Hindoo and Buddhist philosophy this world is commonly viewed as an illusion, the veil of Maya swept around true reality.[2288] Somewhat similarly, a Platonist will regard the world of the senses as but a reflection of the more real world of ideas. The sceptics of yore suspended judgement as to the validity of their own sense perceptions, whereas the ancient Gnostics as well as some modern and postmodern ones hold this world to be a kind of paranoid illusive trap to be fled by all means. For one thing, the idea that the world is akin to a virtual reality simulation is prevalent in much science fiction literature[2289] and was taken to its logical, suicidal end-point by the *Heaven's Gate* cult, also known as the Hale-Bopp sect.[2290] From a more philosophical point of view, Bishop Berkeley drew the extreme idealist conclusion of Locke's empiricism, but understandably made few disciples in the land of common sense and plum pudding. Much more successful was Kant, the father of most modern, epistemologically motivated constructivism, who made the famous distinction between "das Ding für uns", constructed by the synthesising activity of the subject and the categories that condition all perception, and the utterly unknowable "das Ding an sich", providing through his "transcendental idealism" the impetus also for the subsequent Romantic Idealism. Likewise, the modern physicalists and neuromonists claim that the world of the senses is but a construction of the brain, different from the 'real' reality of elementary particles and forces, quarks, and suchlike. Lately, the French philosopher Baudrillard has made himself a name in postmodern circles by construing the modern world as a grand, "hyperreal" fake of "simulacra and simulation" without originals; similar views, rejecting the idea of an objective reality behind the various constructed realities, are generally espoused by the postmodernists.[2291] But, albeit subscribers to different forms of constructivism, the postmodernists are no metaphysical idealists, nor are the physicalists or neuromonists, but rather most of these present-day "irrealists" tend in reality to be hardcore materialists, just a little disguised.

Although it is widely recognised that virtual reality would be suggestive of some kind of dualism or idealism[2292], it is very hard to find any author dealing with the philosophical aspects of virtual reality who really advocates dualism or idealism.[2293] The reason why this is so is not difficult to perceive, as dualism and idealism have been cavilled at in the philosophical debate for decades. The authors writing on the new hip and chic technology of virtual reality are almost unexceptionally committed to fashionable, basically atheist-materialist agendas of different shades – be they postmodern, deconstructivist, radical-Marxian, feminist, cognitivist, or even positivistic-scientistic –, in all of which the 'dualist' tradition of Plato, Descartes, and, in particular, Christianity is a major odium.[2294] Instead, we read in this literature a lot about Leibniz, Heidegger, and

[2288] More recently, [McGi79] presents an intriguing personal philosophy based on the Maya concept. Also the Swedish philosopher Tage Lindbom has made creative use of this concept.

[2289] See [Davi98] p. 279 et seqq. Cf. also [Hayl99] p. 160 et seqq.

[2290] See [Davi98] p. 242 et seqq.

[2291] See [Baud94].

[2292] See, for example, [Heim93] p. 88 et seq., [Mark96b] p. 58, [Zett96] p. 90, [Zhai98] p. 100, [Coyn99] p. 11, or [Hill99] p. 200 et seqq. et passim.

[2293] One exception is provided by the well-known parapsychologist Charles Tart. See [Tart91] and [Tart90]. Cf. also [Bard91].

[2294] Oddly, also the adherents of the kind of trendy neo-pagan and neo-gnostic "spirituality" espoused by, for example, the *VRML* inventor Mark Pesce (cf. [Ples95] and [Slac97]) generally tend to stick to Poortman's *Alpha* standpoint rather than advocating the unfashionable metaphysical standpoints typical of ancient paganism and Gnosticism. Apparently, many neo-gnostics and neo-pagans will not be very serious about their professed religion, which they seem to embrace primarily as a gesture of general rebellion against all and everything, showing off through the support for the traditional archenemies of Christianity their own superb freedom from all the conventional values and moral scruples rooted in the pre-modern Christian society they superbly detest. Thus, this kind of counter-cultural, artificial revival of ancient forms of religiosity may be better characterised as an extraordinarily decadent and profoundly anti-religious expression of nihilistic atheism, the true import of which will be yet another attempt at a Nietzschean "Umwertung aller Werte", showing in, for example, the flaunting of traditional morals and tastes, widespread drug abuse, insalubrious dabbling in the occult, and all kinds of

Baudrillard, none of whom seems to be very helpful for sorting out the *metaphysical* implications of virtual reality. Tellingly, it has also been suggested that there is a place for a "strong programme" of virtual reality, which in contradistinction to the "weak programme", which recognises that virtual worlds are but simulations and nothing more, would assert that virtual worlds can be as real as the physical world.[2295] Although not using the term "strong programme", Philip Zhai attempts to show the reasonability of such a claim in a book-size treatise, which, however, it is hard to find very convincing.[2296] But does this imply that he advocates dualism or idealism, i.e. Poortman's *Epsilon* or *Zeta* standpoints? Nowise; instead he subscribes to the kind of monistic marriage of neuroscience to various physical theories that is often bandied about by speculatively inclined pop physicists and other scientists, who generally tend to end up in vague metaphors and woolly phrases about "quantum consciousness", "the holographic paradigm", "microtubules" in the brain, and suchlike, which is to say that he like those theorists – and, indeed, the advocates of strong AI, whom he, however, criticises at some length – remains well within the *Alpha* standpoint, committing the usual materialist fallacy of reducing spirit and consciousness to what it evidently is not, viz. some element in a theory of modern physics.[2297]

Although virtual reality may be used for suggestive metaphysical thought experiments, this very suggestiveness may also be grossly misleading. Virtual reality is *not* reality, and we should recall how Dr. Johnson easily refuted Bishop Berkeley's idealism by kicking a stone. Indeed, the regularity, clarity, tangibility, and manifest "realness" of our usual reality, as proved by the act of kicking a stone or knocking a desk, set the "real" reality apart from the artificiality and irreality of virtual worlds and in the end will lend more support to the stance of realism than to constructivism or idealism. Still, virtual reality may perhaps awaken those ready to be illumined to the irreducibility of spirit much in the same way as may do the perusal of the *Genesis* account of how God "formed man of the dust of the ground, and breathed into his nostrils the breath of life" or the contemplation of the Greek myth of how, at Panopeus in Phocis, Pallas Athena inspirited the clay figures shaped by Prometheus.

All in all, there is really nothing of substance in the field of computing and computer science to vindicate the metaphysical presuppositions of the fathers of the field, although a quick glance at the ongoing philosophical debate over computers may give the incorrect impression that these presuppositions have indeed weathered well. On the contrary, even the very sweeping survey and discussion in the present section have enabled us to draw these three important conclusions:

1) As the idol of the Golem obviously recedes further and further away into the land of pipe dreams and fairy-tales, the gallant pronouncements of the advocates of the *strong AI* and *strong AL* agendas ring more and more hollow. The all too obvious explanation for the debacle of these agendas is that their metaphysical presuppositions were wrong, as *real* intelligence, life, mind, and consciousness simply cannot be reduced to material principles at all, but derive from the life of the spirit, which belongs to an ontological order altogether different from that of the material.

2) To many reflective observers of the construction of computer hardware and software systems, the experience accumulated from these endeavours has altogether corroded the credibility of the naturalist and Darwinist presuppositions of modern science by showing once and for all that real, functional complex systems will never be able to arise from random processes, but will always require the most meticulous *intelligent design*. Arguably, no thinking engineer can be a Darwinist!

3) Reflection on the philosophical lessons of *virtual reality* systems will lend at least moderate support to epistemological realism and classical Christian-Platonic metaphysics (i.e. Poortman's *Delta-Epsilon* standpoints) rather than to illusionist, monistic – idealistic or materialistic – standpoints.

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effete nihilistic-anarchistic poses. Although the wave of neo-paganism and neo-gnosticism may superficially seem to fit McLuhan's primitivist prophecies about the 'global village' excellently, it will thus in fact rather substantiate his lurid forecasts concerning 'discarnate man'.

[2295] In [Heud99b] p. 23. See also footnote 1379 on p. 273 above.

[2296] [Zhai98]

[2297] Oddly, he (in p. 114 et seq.) speculates about $\sqrt{-1}$ in Schrödinger's wave equation (and various other physical equations) being the "consciousness factor".

Thus, having heeded the Golem's advice and completed the needed modicum of philosophical meditation "the other way around", we saw the Golem become dust and ashes before our eyes!

3.4.3 EXTREME SCIENCE

After all, the prince of this world is a very great electric engineer.

Marshall McLuhan[2298]

Ultimately, this so-called post-modern period is not so much the age in which industrial modernity has been surpassed, as the era of the sudden industrialization of the end, the all-out globalization of the havoc wreaked by progress.

Paul Virilio[2299]

Everything which exists at present – not only external nature – is deemed disposable, is considered an instrument towards the excessive goal of a perfect satisfaction of man's needs, a secularized Kingdom of God on earth.

Reinhart Maurer[2300]

Den stormande tekniska utvecklingen i vår tid, denna måttlöshet och besinningslöshet är icke en seger utan ett förlorat herravälde. Denna förlust är självförvållad. I samma ögonblick, som västerlänningen upphäver distans och nivå i förhållande till materien, är han icke längre herre över materien, hur många sinnrika tekniska kombinationer han än kan utvinna av densamma. Andens aristokratiska herravälde över materien har upphört. Intressemänniskans seger under det nittonde seklet innebär det andligas förening med det materiella under den bedrägliga föreställningen, att människan därmed förenar sig med det »verkliga» och samtidigt blir det »verkligas» bärare.

Tage Lindbom[2301]

Although one might be sceptical about the likelihood of each of the calamitous scenarios prophesied by the various Cassandras of technoscience – that, for instance, a nanotechnology experiment getting out of hand will be able to transform the biosphere into grey goo, that the strong AI and AL adherents will create intelligent artificial life or suprahuman robots that will render man obsolete or oust him in "the struggle for survival", that biotech gene-manipulators and cloners will, by accident or by design, create the mutant germs that kill off all other life, or that someone finally will push the button that brings about the Armageddon of a large-scale nuclear war –, it is hard to disagree with those who assert that, all things considered, technoscience now appears to have transmuted into something of a monstrosity, menacing the very existence of mankind, and, thus, shout "écrasez l'infame" for all they are worth.[2302] After all, the lack of realism of *some* of these inauspicious agendas unfortunately does not extend to all of them, and we cannot reckon that a, to all appearances on the main only imaginary, self-imposed restraint amongst the scientists together with some ethical committees, certainly altogether inadequate for the formidable task, will save mankind forever. One of the lessons of the personal computer and the Internet revolutions is after all that in a sufficiently large population there are surprisingly numerous disgruntled cynics, who for various reasons are willing to spend considerable effort to wreak as much havoc as they can. If these misanthropists happen to be scientists or politicians instead of hackers, the genie let out of the bottle may certainly be something far worse than a computer virus.[2303]

2298 From a letter to Jacques Maritain quoted in [Davi98] p. 254.

2299 [Viri00] p. 139

2300 [Maur83] p. 264

2301 [Lind79] p. 91.

2302 The risks for imminent human extinction as well as various extinction scenarios are discussed and analysed at some length in [Lesl98].

2303 That far from all scientists are men of high ethical principles can be gathered from works such as [BW82], [Kohn86], [Berg84], and [Milt96].

One trenchant and coruscating critic of the current state of science is the French Catholic philosopher and artist Paul Virilio.[2304] In his diatribe *The Information Bomb,* he argues that *science,* partly as a consequence of the arms race, has increasingly given up the search for truth about reality "to become part of a phenomenon of generalized virtualization".[2305] The resulting, purely instrumental *techno-science* has, according to Virilio, given up all reason and conscience and by its obsession with *limit performances* in areas such as robotics and genetic engineering draws the scientific disciplines into a *post-scientific extremism* that indulges in an uncanny gamble where mankind and, thus, science itself are put at stake.[2306] Thus, present-day science can, according to Virilio, be aptly characterised as *extreme science.* As knowledge becomes increasingly *cybernetic* – what Owen Barfield used to call "dashboard-knowledge"[2307] –, techno-science as "mass techno-culture" becomes "the agent not, as in the past, of the acceleration of history, but of the dizzying whirl of *the acceleration of reality"*, which leads to the eclipse of the real for a heightened virtual reality. Thus, the old "science of verisimilitude, of the plausible" is replaced by the "science of implausibility". *Extreme science* with its fixation on "limit performances" and its apparent *Lust am Untergang* is much like the current *extreme sport* on steroids and drugs or the *extreme art* pre-occupied with the breaking of all taboos through the most disgusting forms of vulgarity, obscenity, and execrableness: Just like the sporting hero pushes himself to his physical limits or the artist pushes himself beyond all sense of decency and honour, the scientist pushes himself to his ethical limits, blithely incurring the fascinating risk of the "Accident to end all accidents". Virilio's notion of *extreme science* also reminds us of another French Christian thinker, Jacques Ellul, and his thesis that the modern replacement of nature with an artificial environment created by *technique* is a kind of wager, a bet on man's ability to control the world to his own advantage, resting on what Ellul calls the "technological bluff" and Ehrenfeld "the arrogance of humanism", an absurd discourse of deceit obscuring the total unreason and unfeasibility of this entire project, which in fact is pervaded by a reckless attitude of "after us the deluge".[2308] *Extreme science,* of course, also brings us back to Voegelin's gnostic hypothesis, for what all this "extreme" trespassing of all limits ultimately comes down to is a rather typical gnostic attempt at a break-out from the order of the cosmos as instituted by the resented Demiurge, from whom the gnostic turns away in wrath and denial.[2309]

A strong streak of Faustian pneumopathology can be discerned in many of the leading proponents of the strong programmes of virtual reality, artificial intelligence, and artificial life, of robotics, of nanotechnology, of neo-Darwinism, of genetic engineering, of cloning of animals and humans, and of the various other pursuits of "extreme science", as though these enthusiasts were engaged in a Nietzschean unholy war against not only the Christian religion and all traditional values, but, indeed, against mankind itself and anything that gives meaning to human existence, as most extremely articulated in the craving for the end of humanity and the arrival of the "posthuman" era.[2310] But on closer analysis those advocating the various variants of the "science of implausibility" seem to indulge in charades, a kind of nonsensical propaganda game, which, I gather, may rather appropriately be characterised by Voegelin's terminology of "deception", "intellectual swindle", and

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[2304] See [Viri00] and [Viri97].

[2305] [Viri00] p. 2. As well demonstrated during the last century, the logic of fear driving all arms races tends to ensure that every terrible weapon that can be imagined is also swiftly implemented, since otherwise the enemy would be likely to get at it first. Thus, ethical considerations are more or less automatically suspended in this kind of process. That this logic of fear has compelled not only totalitarian "empires of evil", but also democratic countries to pursue ethically extremely disturbing research – including revolting medical experiments on human subjects – can be gathered from such works as [Mark91], [Thom88], [Vict99], and [Andr01]. Some authors refer to the idea that everything technically possible will sooner or later be implemented as "the technological imperative" (see [Wrig86] p. 138 et seqq.).

[2306] Virilio also astutely points out the rather odd fact that these extreme limit performances largely seem to be centred at the American West Coast, as though the American conception of the frontier, where lawlessness and chaos once used to rule supreme, was somehow transformed, sublimated, or virtualised into other forms of impetuosity at Silicon Valley and Hollywood, as the Pacific Ocean put an end to further geographical expansion and the zone of lawless chaos disappeared.

[2307] See [Barf88] p. 55.

[2308] [Ellu90] and [Ehre81]. Cf. also [Jona84] p. 34 et seqq. and [Grah00b] p. 39 et seqq.

[2309] This gnostic approach to reality is well summed up by Marvin Minsky, the doyen of artificial intelligence research (see [Rhod99] p. 369): "Look, the world is a rather dumb place. There's nothing special about it. It's accidental. The world was *terrible* before people came along and changed it. So we don't have much to lose by technology. The future of technology is about shifting to what people like to do, and that's entertainment. Eventually robots will make everything."

[2310] [Viri00] p. 140 observes that the "global warfare" prepared by extreme science does not, as in the wars of old, threaten only the enemy or, as the "total war" experimented with during the First and Second World War – and in particular at such foci of horror as Hiroshima and Auschwitz – only particular populations or races or, as the thermonuclear bomb, the human race in its entirety, but "the very principle of all individuated life".

“demonic mendacity”[2311], for rather than being the works of simple asininity or puerile fantasy the arguments in favour of these agendas are wrought with much sophistication by excellent minds, albeit ones seemingly afflicted by a strange Mephistophelean commitment to what in the end boils down to cheap and unsavoury absurdity.[2312] Yet, for all their authors’ pretensions to faith in their own highly wrought shenanigans, there remains a peculiar, hollow, gnostic ring of untruth, decadence, madness, and not seldom silliness about the proclamations of these techno-Mephistopheleans. Oddly, one gets the impression that they play games no less with themselves than with their readers, intoxicating themselves, as it were, with their own tirades so as to make a phoney dream reality consistent with their wishes appear before their inner eyes. It is not difficult to perceive from what source all this pneumopathology springs forth, to wit the long-standing, seemingly ever-resurgent gnostic rebellion against existence, the revolt that started as a reaction to, or perhaps rather, against the Christian gospel and seemingly culminated with the great 19th century “doctors of modernity”, Comte, Marx, Freud, Nietzsche, and, Darwin. Who can truly count the billows of inanity that have swept the shores of Western science and culture, flowing forth superabundantly from the wellsprings of Darwinian evolution-talk and all the other nihilist and anti-Christian agendas, the bitter and mephitic waters of which ever and again have turned out to poison whoever tastes them fatally, paralysing the imbiber’s common sense and inspiring in his mind all kinds of inebriating hallucinations?

The predominance of naturalism amongst scientists and engineers is of course not unrelated to the circumstance that naturalism, by virtue of its being closely coupled to value subjectivism, sets its adherents free from all deep moral considerations and, thus, in effect will act as a tranquillising pill against the scruples and the pangs of conscience that naturally would disturb the work on the often ethically highly distressing tasks that fill many scientists’ and engineers’ weekdays. But this will not be the whole truth. The entire technoscientific attitude towards reality of vehement manipulative domination and insensitive and callous objectification, itself the indelible legacy of the black arts, from which science never emancipated itself save for the choice of apparently more efficient methods, all this brutality towards nature, the landscape, culture, animals, corpses, man himself, and his poor soul, epitomised by all these ugly, roaring, and reeking icons of modernity, the bulldozer, the functionalist asphalt and concrete jungle, the shanty town, the motorway and the airport, the nihilist grimaces of modern music and art, the abattoir, the forbidding spectacle of vivisection and autopsy, the total war, and the enterprise of social engineering, which, zealously pursued by the conditioners and exterminators of political gnosticism, extends the grisly instrumental, ‘scientific’ treatment of animals also to man himself, by necessity sears the soul and predisposes it to despondency, cynicism, naturalism, Darwinism, and atheism.[2313] This technoscientific attitude contrasts sharply to the ‘pre-scientific’, or shall we rather say ‘pre-lapsarian’, religious-philosophic attitude towards reality, the humble adaptation of man’s soul to reality, suffused and energised by the love of the divine Ground, in full reciprocity.

Beneath the surface, there is a strange vicious loop built into the technoscientific outlook, as each time the disturbing question of the Ground re-surfaces, it will be rebuffed by reference to the badness of things, as though the point of all this technoscientific re-construction and destruction of reality, the din, ugliness, and cruelty of the modern world, was really the annihilation of this very question so as to make good the gnostic depreciation of the Demiurge by implementing on Earth not Heaven, but Hell! Nay, there is not only a single vicious loop, but a whole skein of such loops, which together ensure that there can be no way back and no way out of the trap gnostic-scientific man created for himself and mankind. Virilio summarises the sentiments of despair that stand as the paradoxical end-result of the gnostic quest for inner-worldly fulfilment thus:

[2311] See above p. 341. Notably, Turing’s ideas on thinking machines can easily be construed in terms of “intellectual swindle” and “demonic mendacity”, as Turing evidently understood that they were incompossible with the truth of existence, but still chose to advocate them.

[2312] This does of course not mean that all scientists working in these fields are to be characterised in this way. On the contrary, most researchers, being active in some strictly circumscribed subfield of their speciality, will prefer to stick to their last and tend to be markedly reticent, guarded, and circumspect as to issues that fall outside their own realm of expertise, leaving the grand claims, to which they may or may not assent, to small cliques of vociferous élite scientists and ideologues. Still, most scientists will probably be at least vaguely sympathetic to the general metaphysical thrust of their own branch of science.

[2313] Cf. also the reflections in [Feye87] p. 20 et seqq.

As mere men and women, mere terrestrials, the world for us today is a dead-end and claustrophobia an agonizing threat.[2314]

Thus "extreme science", just like its equally euphorically celebrated forerunners "extreme selfishness", "extreme nationalism", and "extreme politics", inevitably ends up in disappointment, hopelessness, and madness. As a result of man's plasticity, which is the corollary of his free will, the fundamental intentionality characteristic of his being, this directionality, which, according to the Christian faith, will be properly satisfied only through the *visio beatifica* in the next world, lends itself to all kinds of idolatrous perversions, as exemplified by the "extreme" cults of the national state, the working class, superman, personal wealth, darkness, technoscience, or whatever. But although consequently the prospects for *mankind* indeed may look glum, now as always, particularly if one attaches one's hopes to such "extreme" gnostic will-o'-the-wisps of innerworldly salvation, there is, at least for those willing to look outside this world and put their faith in the Kingdom of God[2315], no use despairing, as *each man* can still, now as always, by Divine grace, turn away from gnostic idolatry towards *the* proper object of his own intentionality.

[2314] [Viri00] p. 131

[2315] On the antithesis of the Kingdom of God and the world, see [Gay98] p. 3 et seqq.

Science sans conscience n'est que ruyne de l'âme.

François Rabelais[2316]

There is something which unites magic and applied science while separating both from the "wisdom" of earlier ages. For the wise men of old the cardinal problem had been how to conform the soul to reality, and the solution had been knowledge, self-discipline, and virtue. For magic and applied science alike the problem is how to subdue reality to the wishes of men: the solution is a technique; and both, in the practice of this technique, are ready to do things hitherto regarded as disgusting and impious– such as digging up and mutilating the dead.

C. S. Lewis[2317]

The magus does not recognize sin; he is, in a way, above morality and the law, a law unto himself.

Georg Luck[2318]

On the contrary, their and their technical fellows' apparent success can be paradoxically attributed to their command of surplus psychic energy for "directed thinking". It is the energy which - as hilariously pointed out by Lindbom … - becomes freed when thinking is divorced from feeling, and ethical responsibility is ignored or transferred by the "facilitator" to the "invisible hand" of a negotiation process. Certain insights can, for good and for bad but perhaps mostly for good, be paralyzing when psychic energy is not freed and made available to wanton doing but, rather, remains tied to the ethical inwards struggle.

Kristo Ivanov[2319]

'There are perhaps just wars, but there are no innocent armies', or so the saying goes. From now on, it is the same with science as it is with war: there is no longer any really innocent science.

Paul Virilio[2320]

Son of man, these men have set up their idols in their heart, and put up the stumblingblock of their iniquity before their face: should I be inquired of at all by them?

Ez. 14:2

The paramount incentive to write the present, lengthy chapter, which now at long last approaches its conclusion, was my own need to somehow come to terms with and sort out the ethical implications of the technologies involved in the agenda of "realistic computing" discussed previously. In particular, the possible repercussions of such a Faustian endeavour as the creation of a *virtual reality* or VR-based *cyberspace,* which would compete with or even perhaps ultimately supplant our ordinary reality appeared to me increasingly disturbing and questionable, as I penetrated deeper into the VR literature and contemplated the various ideas bandied about by the leading figures in this field. Can work on such a technology, pregnant with the lurid dangers and menaces amply described in the literature, really be morally justified? Ought we to engage in the digital reconstruction and virtualisation of the world at all? Or are we here infringing on areas that are better left unexplored?

To be able to deal adequately with the literature on the ethical aspects of computing and the various points of view that appear therein, we first need to recognise that ethics is closely coupled to metaphysical,

[2316] [Rabe1532] chapitre VIII

[2317] [Lewi96a] p. 83 et seq.

[2318] [Luck85]

[2319] [Ivan93b].

[2320] [Viri00] p. 31.

philosophical, and theological standpoints.[2321] The most fundamental division line in ethics runs between those who acknowledge that there is some kind of objective value order in the universe, by which man has to abide *(value objectivism),* and those who claim that values are subjective and, in principle, arbitrary *(value subjectivism* or */value/ nihilism).*[2322] The former position presupposes the existence of some kind of suprahuman authority or realm that will provide the legitimisation of the objective values, whereas, in contrast, the latter cannot brook any such power in order to be able to ensure the subjectivity of all values.

Value subjectivism or *nihilism,* which thus tends to be more or less synonymous with *atheism* and *naturalism,* denies that there is any ultimate, independently existing value ground from which ethical judgements can be made. Thus, value terms such as "good" and "bad" do not refer to 'real' existents, but are rather expressions of subjective opinions or emotions *(emotivism)* of no real validity, whereas, according to this conception of ethics, the 'real' is to be equated with the 'objective' or spatiotemporal *(materialism).* Thus the maxims "do what thou wilt" and "everything is permitted" will be the natural corollaries of value subjectivism. Nonetheless many value subjectivists opine that we, when contemplating the consequences of our actions either as individuals or collectively, ought to strive to maximise some kind of purportedly positive value *(utilitarianism),* such as pleasure *(hedonism)* or happiness *(eudemonism).* However, the fundamental postulate of value subjectivism that values are wholly arbitrary seems immediately to undermine the legitimacy of such undeniably *ethical* precepts. If all value propositions are subjective, so are the value statements i) that we at all should strive for maximisation of a certain value rather than not or ii) that we should choose to maximise just *pleasure* or *happiness* rather than some other arbitrary value of our own liking. In his famous dystopian novel *Brave New World,* Aldous Huxley laid bare the chilling ramification of this kind of philosophy, and few readers of this classic tome of dystopianism would probably deny that a life sanitised from unhappiness, suffering, and adversities would be a most terrible thing.[2323]

In practice, many value nihilists, and in particular those who have crossed the threshold to Kierkegaard's ethical stage[2324], will be able to lead a reasonably decent life by falling back on their own conscience, education, or good-natured disposition – if they are happy enough to be in possession of one or more of these –, some vague altruistic ideas, some 'ersatz religion' or ideology, the example set by some moral paragon whom they admire, or, in the last resort, the ethical principles touted in the society in which they live, although they in theory reject the validity of all of these. Alas, others, taking their value nihilism seriously and staying put at Kierkegaard's aesthetical or ironical stages, will become egotists, cynics, bounders, self-serving hypocrites, unscrupulous careerists, or even anarchists, terrorists, mobsters, or waylayers.

Value subjectivism is closely coupled to what is occasionally referred to as *objectification,* i.e. the act of depersonalising other beings so as to be able to regard them and treat them as 'just objects'. By objectification, the use of our usual sense of propriety and conscience is suspended through what can be construed as a reversion of the Christian commandment of love, viz. an act of shutting oneself off from any sentiments of sympathy and compassion. If, according to the Christian understanding of these things, man, by opening his heart to God's grace, may, to the best of his ability, act as a, by necessity imperfect, conduit for the divine love, *agape,* that also is the fountainhead of being, objectification constitutes the very opposite to this receptivity to divine grace, instead implying that man shields himself off from the divine love and energy.[2325] Thus objectification is the mechanism, which enables men to do and enjoy things that naturally repel them, such as hunting animals or treating them cruelly, performing surgery, autopsies and vivisections, setting up slaughterhouses and concentration camps, waging war, enslaving, mobbing, persecuting, or killing their fellow men, or taking pleasure in violent and vulgar forms of entertainment. Objectification also plays a constitutive

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2321 [Mitc94] and [MG84] provide excellent introductions to the fields of "the philosophy of technology" and "the theology of technology", respectively. More references to the literature can be found in footnote 2103 on p. 457.

2322 Some philosophers contend that values are derivable from empirically observable properties, such as "being liked by most people" *(value naturalism).* As this standpoint only blurs the fundamental distinction between *value subjectivism* and *value objectivism* and its soundness has been rather widely questioned on what appears to be good grounds ("the naturalistic fallacy"; see [Lübc87] p. 97 and p. 438 et seqq.), I will not pay any attention to it here.

2323 [Huxl55]

2324 See above p. 302.

2325 In particular, the advocates of different strains of *personalist* and *dialogue philosophy,* such as Marcel, Renouvier, and Buber, have attempted to formulate thoroughgoing critiques of the modern tendency of objectification. Cf. also [Barf88] and [Lang00] p. 130 et seqq. On the Christian conception of *agape,* see [DArc46] and [Nygr47].

rôle in both magic and technoscience, which both require a reality constituted by 'just objects', which can be investigated and manipulated in various ways without having to heed "conscientious objections".

In the unforgettable and unsettling seventh discourse of *Les Soirées de Saint-Pétersbourg,* Joseph de Maistre lets the senator portray the ghastly effects of man's unquenchable thirst for blood, at one and the same time both the corollary and the punishment of his own original sin, which, being repeated at every instance in history,[2326] must until the consummation of time also be expiated again and again by the incessant immolation of living beings, the never-ending butchery and bloodshed that, according to de Maistre, in effect render the entire earth a grand sacrificial altar unto the divine justice:[2327]

> *Au-dessus de ces nombreuses races des animaux est placé l'homme, dont la main destructive n'épargne rien de ce qui vit; il tue pour se nourrir, il tue pour se vêtir, il tue pour se parer, il tue pour attaquer, il tue pour se défendre, il tue pour s'instruire, il tue pour s'amuser, il tue pour tuer : roi superbe et terrible, il a besoin de tout, et rien ne lui résiste.*

Although de Maistre was no theologian and does not dwell on the exegesis of the first chapters of *Genesis* at length, in some interpretations of the *Genesis* story of the fall of man, objectification and value subjectivism constitute the very pivot of the original sin:[2328] By the act of disobedience against God, the first couple, wishing "to be as gods, knowing good and evil", proudly reaches out for the comprehension and control of what is to be considered right and wrong. But by tasting this forbidden fruit, their apprehension of reality and themselves is immediately altered, becoming tainted by sinful objectification, as "the eyes of them both were opened, and they knew they were naked". This act of disobedience turned out to corrupt the creation in its entirety, which thereupon drastically changed for the worse, as man, having been clothed by God in "coats of skins", was expelled from the garden of Eden to roam "the ground from whence he was taken", a ground cursed by God in punishment for man's offence. Indeed, modernity starts with the gradual eclipse of the Genesis story of the original sin and the fall of man and the rise of the Hermetic myth of man as a magus and co-creator, a terrestrial god, to whom nothing is impossible, followed by a strong thrust to universal objectification and "mechanisation", as laid down in the philosophical works of Francis Bacon and Descartes and articulated in the arts, medicine, science, etc., most strikingly perhaps in the Baconian programme of putting nature to the rack through experimental science.

That the essential theoretical arbitrariness of value subjectivism is deeply problematic, making the value subjectivists' moral judgements appear, as it were, *in aere aedificata,* and lends itself to all kinds of attempts at more or less unsavoury *Umwertungen aller Werte,* where just about anything, including criminality, indoctrination, extortion, torture, slavery, perversion, or murder, can be gratuitously legitimised, has repeatedly been demonstrated throughout history, in particular in the events of the two last centuries through the kind of new "ethics" promulgated by various basically value nihilistic ideologies, such as communism, national socialism, fascism, anarchism, secular humanism, libertarianism, feminism, social democracy, or liberalism, just to name some of the isms that emerged in the wake of the French Revolution. Indeed, the manipulation of values in order to promote this or that agenda or interest group has become more or less institutionalised by representative democracy, reflecting the ethical subjectivism that is germane to the more general disorientation of a modernity founded on the barefaced abolition of God, the self-divinisation of man, and the declaration of "the rights of man" – the very antithesis to the Sermon on the Mount, Christ's harsh and unrelenting declaration of "the duties of man" and exposure of man's sinful and evil fallen nature. Whereas many value subjectivists will be willing to acknowledge that the moral experimentation has occasionally got out of hand, at least in such extreme implementations as the Gulag, Auschwitz, Hiroshima, or the Killing Fields, they will still contend that value nihilism is the natural consequence of intellectual honesty, of taking the naturalistic world-

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[2326] [Mais80] vol. I p. 63

[2327] [Mais80] vol. II p. 23

[2328] For one thing, St. Augustine took the essential component in man's *peccatum originale* to be *concupiscentia,* a kind of wrongful, objectifying desire, whereas St. Thomas interpreted it as an illicit attempt, incited by our first parents' *superbia* (pride), to take control over what is right and wrong. [Ellu84a] and [Broo97a] p. 177 et seqq. provide two attempts to relate the Genesis account to science and technology. Cf. also [Lind86a] p. 132 et seqq.

view that science – and, in particular, Darwinism – presents us with seriously, although, from the point of view of value nihilism, it indeed seems incomprehensible why anyone should need to heed the duty of being intellectually honest or how it would be possible to establish that some moral experimentation is bad and some other good.

Furthermore, as we have argued at some length above, science is not a metaphysically or religiously neutral process, but is itself deeply implicated in and coloured by certain metaphysical-philosophical-ethical agendas. In actuality, the scientific naturalism and atheism that *prima facie* may seem to ensue from science, but *de facto* constitute the metaphysical substructure which controls the scientific pursuit almost entirely today and, paradoxically, make this very naturalistic bias of science appear to be a side-effect rather than the presupposition it really is, are themselves also the very instruments, through which the ethical restraints, against which technoscience routinely trespasses, can be abolished and re-structured into all kinds of novel, artificially composed "ethical systems".[2329] From a Christian viewpoint, scientific materialism must be interpreted as the backwash of the original sin, man's brazen attempt to take control of good and evil through objectification and value subjectivism. But this scientific materialism is based on what, as we argued above, are evidently counterfactual premises, the blunt denial of large parts of reality, and the construction of a naturalistic-scientistic fake reality of the typical gnostic cast so well accounted for by Voegelin. Indeed, St. Paul's pithy observation, in effect making value subjectivism and the pathologic denial of truth the ultimate causes of the "strong delusion" – "scientific materialism", naturalism, atheism, modernism, etc. – God visits upon those taking "pleasure in unrighteousness", says it all:[2330]

> *And for this cause God shall send them strong delusion, that they should believe a lie: That they all might be damned who believed not the truth, but had pleasure in unrighteousness.*

Unlike value subjectivism, *value objectivism* recognises the existence of objectively valid moral precepts, values, or ethically qualified ideas, such as goodness, justice, truth, holiness, and beauty. To be authoritative, the 'natural law' comprising these precepts, values, and ideas must be grounded in some kind of suprahuman, spiritual, or divine realm, such as the *Logos* of the Greek philosophers, St. John, Philo, and the Christian theologians. Additionally, in this conception of ethics man is usually held to be endowed with an innate capability to perceive through his own *heart, conscience, synderesis,* or *moral sense* the *lex naturalis,* through which is regulated what is right and wrong, although admittedly this natural capacity may at times become severely occluded or perverted and may need to be assisted by precepts and rules given more directly, for instance by means of holy traditions, sacred scriptures, moral exhortations, spiritual education, etc.[2331] Occasionally, the existence of a *moral sense* has been postulated in order to underpin the thesis that religion is unnecessary for moral behaviour, but more often man has been supposed to be able to make full use of his moral capabilities and to clearly discern what is right and wrong only if he devotes himself in earnest to religion and the life of the spirit, whereas the godless man, the hypocrite, and the materialist generally have been deemed to be morally decrepit, if not outright wicked, "fools" lacking in spiritual maturity and insight.[2332]

There is considerable, albeit of course not complete, consensus across cultures and religions as to what constitutes ethical and non-ethical behaviour. C. S. Lewis for one, in the *Abolition of Man,* attempted to outline the core of this ethical *consensus gentium,* which he called the *Tao,* a term I will also adopt below, and held to be intuitively sensed by all men.[2333] In scholastic Christian theology, the *Decalogue,* also referred to as the *lex*

[2329] See [TO95] p. 172 et seqq. for an instructive case story concerning the moral quandaries implied in ethically doubtful scientific projects and the scientists' strategies to avoid facing these.

[2330] *2 Ep. Thess. 2:11-12.* Cf. also *Ev. Jo. 3:19:* "And this is the condemnation, that light is come into the world, and men loved darkness rather than light, because their deeds were evil."

[2331] According to the orthodox Lutheran theologians of old, man's innate capacity for acts of conscience was, like his intellect and natural reason, seriously vitiated at the Fall. Ever since, man is often misled by *conscientia erronea,* i.e. his own false intuitions as to what constitutes the good.

[2332] See above p. 303 et seq.

[2333] See [Lewi96a] p. 91 et seqq., where are enumerated various examples of moral rules typical of the *Tao* garnered from different cultures and presented under the eight headers, "the law of general beneficence", "the law of special beneficence", "duties to parents, elders, and

Mosaica or *lex moralis* (in contrast to the *lex ceremonialis* and *lex civilis* also given in the Books of Moses, but intended specifically for the Jewish nation under the dispensation of the Old Testament), summarises the *lex naturalis* impressed by God on all men through the innate capacity *(habitus)* called *synderesis,* by which man through the act *(actus)* of *conscientia* spontaneously grasps this natural law.[2334] Likewise, according to Max Scheler, this kind of knowledge concerns *values,* which, he insists, are objective and invariant *essences* – such as beauty – reflected in valuable things, *Wertdinge* – e.g. a beautiful flower –, and, thus, is a form of *Wesenswissen,* attained through special acts of *Wesensschau,* to wit *valuations,* which, in contrast to the *values* intuited through them, are imperfect, variable, and partly subjective feelings and experiences of value.[2335]

Modernity (and postmodernity) with its ideologies and isms differs radically from traditional culture by having stepped out of this universal ethical standard, the *Tao,* altogether, although there are of course also considerable differences in ethical attitudes and precepts between different traditional religions and cultures, and there also exist various examples of 'degenerate' cultures and nations that just like modernity more or less consciously have deviated from the *Tao.*[2336] In particular, Christian apologists have not failed to note that *pantheism*[2337]*,* in contrast to *theism,* may lead to the view that, since, from a pantheist point of view, everything, including all humans and other living beings, is God and history is God's play *(lila),* in which epochs of ethical perfection and ethical imperfection may follow upon each other according to some more or less strictly regulated cyclical scheme, as, for example, laid down in the Hindoo doctrine of the *yugas,* any act of moral turpitude and cruelty will in the pantheist conception of the world be in some sense sanctioned by the divine or the divine world order, and will, at least from some lofty point of vantage, be no less a part of the divine play than an act of love or noble purpose, even though men, from their limited perspective, tend to split up reality, which in actuality is one, in contraries of good and evil.[2338]

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ancients", "duties to children and posterity", "the law of justice", "the law of good faith and veracity", "the law of mercy", and "the law of magnanimity".

2334 To which of the two *facultates animae,* will or intellect, the *synderesis* belongs was disputed by the Schoolmen.

2335 See above p. 321. Scheler also arrays the values in a hierarchy of four levels *(Wertmodalitäten),* of which the higher levels always take precedence over the lower ones. These four levels concern i) pleasure (the pleasant/unpleasant perceived directly in our sense impressions), ii) vitality (the noble/ignoble perceived through emotions of joy, courage, anxiety, hatred, etc.), iii) the spirit (beauty, justice, truth, etc. perceived through certain "aesthetical" experiences, our sense of justice, etc.), and iv) religion (the holy/unholy perceived in experiences of bliss and despair), and with each level he associates certain characteristic types of disclosers or specialists, viz. "the artist of consumption", the hero, the genius, and the saint.

2336 [Edge92] makes an attempt to survey examples of such "sick societies", although some of his claims and ideas are not beyond criticism.

2337 It should be noted that the "atheistic" religions of India are not atheistic in the sense used here, but are rather to be characterised as "pantheistic". See footnote 1480 on p. 299.

2338 See, for example, [Ches1908] p. 228 et seqq. or [GW84] p. 89 et seq. It should, however, be noted that there is a somewhat similar problem also in the Christian theology of providence. In contrast to God's *providentia specialis* or *providentia extraordinaria,* i.e. the special, miraculous acts, in which God transcends the regular manner He usually works His will by instead using His *potentia absoluta,* absolute power (or *potentia extraordinaria,* extraordinary power) to bring about effects *supra causas,* above (ordinary) causes, or *contra causas,* against causes, God's general or ordinary providence, *providentia generalis* or *providentia ordinaria,* works through "ordinary" secondary causality, in keeping with His *potentia ordinata,* ordained power (also referred to as *potentia ordinaria,* ordinary power). As *continuata creatio,* the continuation of the creation, this *providentia generalis* can be said to be made up of three components, viz. *conservatio,* the conservation of the being of the created, contingent existents, *concursus,* the support of the actions and activities of these contingent beings, i.e. the secondary causality of the created order, and *gubernatio,* the governance by which God through the *causae secundae,* the secondary, instrumental causes sustained by the *concursus,* rules and orders all things by a *continuus Dei in creaturas influxus,* a continuous influence of God on creatures, in accordance with His own *causae finales,* the final causes of his purposes and ordinances, which constitute the *primary* causality of the created order.

The problem appears in the doctrine of the *concursus,* which, being based on God's *omnipraesentia* and *omnipotentia,* omnipresence and omnipotence, as expressed in the concepts of the *immediatio suppositi,* the immediacy of God's subsistence, which pervades and sustains all contingent things, and the *immediatio virtutis,* the immediacy of God's effective power, which sustains the *ordo causarum et effectuum,* the order of causes and effects, may seem to lead to the conclusion that God also concurs in the evil acts of sinful humanity. However, this seemingly worrying problem is dissolved by making a distinction between two kinds of God's *gubernatio* through the *concursus,* viz. 1) *gubernatio secundum beneplacitum,* governance by good pleasure, by which God sustains contingent actions that are in accordance with His own goodness, justice, and mercy and, thus, works His will through His *opus proprium,* the work proper to His nature, and 2) *gubernatio secundum permissionem,* governance by permission, by which He allows also actions contrary to His will and, thus, may work His own will through an evil *opus alienum,* work alien to Him, rooted in human sin. See the respective terms in [Mull85]. This Christian doctrine of providence was to recur in secularised garb in such notions as Adam Smith's "invisible hand", Kant's "Naturabsicht", or Hegel's "List der Vernunft", to say nothing of all the evolutionist and progressivist schemes, according to which nature and history, through the hardships

This blurring of the boundary between good and evil actions will be particularly characteristic of modern forms of pantheism, such as Romantic and "New Age" pantheism, which often implies a radical relaxation and relativisation, not to say revision of the severe moral standards of the theistic Abrahamitic religions, largely as a consequence of a more or less complete rejection, or at least re-interpretation, of the doctrines of the Fall of man, otherworldly punishments, and God as a righteous judge of man's sins.[2339] In actuality, many modern pantheists seem to espouse a somewhat veiled or half-baked value subjectivism, which allows them to set their own ethical standards, by remaining within the *Tao* as long as it pleases them, but stepping outside whenever they prefer to do so. Although in most traditional pantheist and similar systems, such as Shankara's *Advaita Vedanta* and Buddhism, the objectivity of the values of the *Tao* is recognised and the doctrine of post-mortem punishment of wrongdoers upheld, the zeal for ethicality seems here often to be somewhat less perspicuous than in theist religion and be softened in favour of a more fainéant and relativistic attitude to moral questions, at least if the religious élites of monks, yogis, and suchlike are excepted. On the other hand, many hold that the pantheistic attitude, both in its traditional and its New Age appearance, will imply a strong sense for the sacredness of nature and the Earth that may perhaps result in a stricter ethics than that of the modern West when it comes to issues of the environment, the rights of animals, warfare, and the effects of technoscientific 'progress'.[2340]

It should also be noted that even in predominantly religious societies formally guided by some variant of the *Tao,* value nihilism, through such phenomena as "practical atheism" and hypocrisy, or as the consequence of outer and inner pressures of various kinds, may at times play a significant or even a predominant rôle. This will of course particularly often be the case amongst the powers that be, to whom cynicism, recklessness, and an inordinate obsession with power and wealth will always come easy. Various tribulations of human existence – plague, starvation, excessive poverty, war, and, above all, civil war – may also blaze the trail for the wider dissemination of value nihilism.

Taking the attitude to the *Tao* as our yardstick, we may summarise the discussion so far by postulating these three ethical standpoints:

- *Strong value objectivism,* the standpoint paying full homage to the *Tao,* is embraced by orthodox Christianity and, albeit with some restrictions and reservations, by most other forms of traditional religion, including the 'orthodox' forms of the other Abrahamitic religions, most Eastern and primitive religions, and most pre-modern philosophy, in particular in the Platonic-Aristotelian vein.
- *Weak value objectivism,* which, although it does not reject the *Tao* entirely, tends to be both less peremptory and considerably more relativistic about it, perpetrating, as it were, a partial, subjectivist abandonment of it, is characteristic of many modern varieties of pantheistic, panentheistic, or similar strains of religiosity, such as much Romantic and New Age thought as well as of some half-heartedly modernist ideologies and politico-philosophical agendas,

of terrible struggles, bring forth all kinds of beneficial wonders. See [Aspe74] p. 213 et seqq., [Benz83a] p. 37 et seqq., and [Funk86] p. 67 and p. 202 et seqq.

2339 See [Walk64] on how this "decline of hell" proceeded. If we are to heed the testimony of some near-death experiencers, those who consider themselves too sophisticated for such an outmoded "superstition" may be in for a postmortal surprise. See [GE92], [Atwa92], and [Gall84] p. 72 et seqq. Albeit seminal, Rawlings' two books [Rawl79] and [Rawl93] on hellish near-death experiences should be used with caution (see [Sabo98] p. 165 et seqq.). [Bone01] cites estimates to the effect that from 1% to 50% of all near-death experiences contain frightening elements, himself apparently favouring the NDE researcher Atwater's guarded 15% estimate as closest to the truth. [Lund00] briefly compares the reports of NDE experiencers with the traditional division of the otherworld into Heaven (City of Light), Purgatory (Realm of the Bewildered Spirits), and Hell, also supported by, for example, the Marian visionaries of Medjugorje. On otherworldly geography, cf. also [Zale87].

2340 This brings us back to the question why technoscience with its exacting attitudes to man, nature, and reality at large appeared just in Western, Latin Christianity and to what extent its appearance here can be imputed to Christian influences. Above we have, relying on the results and theories of various scholars, argued that the secularising tendency of Ockhamism in the late Middle Ages together with the longstanding influx of Hermetic-Kabbalistic occultism that culminated in the Renaissance Hermeticism, which rendered man a godlike magus and society an earthly paradise, are the real parents of these attitudes, conspiring so as to break down the sensitivity for the sacredness of the world, remove the scruples that restrained Christian man, and strengthen the human will and *libido dominandi.* Whereas the desacralising attitude is particularly conspicuous in Protestant Christianity, as highlighted by its abolition of the cult of the Saints and the belief in miracles, it must, however, be admitted that already the Latin Christianity of the early Middle Ages exhibited a greater openness to technoscientific innovation than any earlier culture that we have taken cognisance of, although the real reasons for this remain moot. See above p. 430 et seqq.

including many varieties of liberal theology, liberalism, conservatism, and social democracy, which, while giving up the core beliefs of the Christian faith and Platonic-Aristotelian philosophy, still cling to some parts of the ethical heritage of the *Tao* and a vague, emotional 'spirituality'.

- *Value subjectivism,* which denies the validity of the *Tao* altogether, is today primarily associated with naturalism, atheism, scientism, secular humanism, modernism, postmodernism, and all the other modern isms, ideologies, and secular religions, but also crops up in the more decadent varieties of occultism and the 'New Age' movement as well as amongst many "practical atheists", cynics, criminals, and suchlike, and, on a larger scale, in ethically derailed cultures and nations, in many cases apparently being adopted without any elaborate theoretical underpinnings.

By and large, these three ethical standpoints also correspond to the three main categories of contemporary Western thought, *traditional theism, mystical syncretism,* and *modernism,* which we suggested earlier.[2341] Thus, the literature engaging technology, media, and computing at large – and cyberspace and virtual reality in particular – from an ethical perspective can also be somewhat grossly partitioned according to which of these three positions they espouse.[2342] So we have a group of *theistic* critics of technology and computing, another of *mystical syncretists,* and, thirdly, we have authors who represent a secular, *modernist* perspective. Below, I will give some examples of the standpoints of various authors, who represent these three perspectives, although it should be emphasised that this survey will by necessity be both brief and incomplete.

Amongst the most prominent in the – predominantly technosceptical – *theistic* group of philosophers of technology, are Jacques Ellul[2343], Romano Guardini[2344], C. S. Lewis[2345], Marshall McLuhan[2346], and Paul Virilio[2347], many of whose works we have already touched upon.[2348] Tage Lindbom[2349] and Philip Sherrard[2350] can be characterised as technosceptical Christian perennialists, who, perhaps, could as well have been classified as traditionalist mystical syncretists. We earlier discussed Lynn White's teetering views as to the benevolence of technology and the complicity of the Christian Church in the modern environmental crisis at some length.[2351] The technooptimistic Baconian tradition is represented by, for example, Friedrich Dessauer[2352] and, more recently, by the Teilhard acolytes Kevin Kelly and Jennifer Cobb, both journalists working for the trendy computer magazine *Wired.*[2353] Cobb has written on computing from a more specifically theological point of view, as have Thomas Langan[2354], Stanley Jaki[2355], Kristo Ivanov,[2356] Vincent Rossi[2357],

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[2341] See p. 457.

[2342] That there is a sizeable literature on such topics is witnessed by [Agre02], a bibliography on "the social aspects of computing" put together by Phil Agre. Although this list only covers *books* (NB!) published in English between 1994 and 1997 and is not altogether complete, its out-print consumes no less than 57 A4 pages. Only a small selection of this huge literature can be discussed here.

[2343] See, for example, [Ellu64], [Ellu70], [Ellu85], and [Ellu90]. Cf. also [Wäst85], [Mitc94] p. 57 et seqq., and [Ferk93] p. 167 et seqq.

[2344] See [Guar98b].

[2345] For this aspect of Lewis' work, [Lewi96a] is of particular note.

[2346] See p. 485 above. McLuhan was of course, generally speaking, not pessimistic about technology, but highly ambivalent about its pros and cons and expressly tried to avoid stating his own opinions on such matters. Nevertheless, in his darker moments he seems to have surpassed all the other philosophers of technology in pessimism.

[2347] See p. 500 above.

[2348] [MG84] is an excellent resource on the 'theology of technology', also providing a very useful commented bibliography. Cf. also [Gray94].

[2349] See, for example, [Lind82], [Lind95], and [Lind99]. Cf. also [Geer99].

[2350] See [Sher87] and [Sher92].

[2351] See p. 430 et seqq. above.

[2352] See, for example, [Dess56]. Cf. also [Tuch64] and [Mitc94] p. 29 et seqq.

[2353] See [Kell94], [Kell98c], and [Cobb98c].

[2354] [Lang00]

[2355] [Jaki89]

David Pullinger[2358], and Douglas Groothuis[2359], all of whom take a considerably more critical view of the alleged boons of technoscience than Cobb.

In the motley group of *mystical syncretists,* thinkers influenced directly or indirectly by Rudolf Steiner's anthroposophy have been particularly vociferous on computing issues. Notably, Owen Barfield's writings provide a mediating link between Steiner's philosophy and some of the more academically oriented of these writers, such as Talbott and Roszak, of which the latter is also heavily influenced by William Blake's Romantic critique of industrialism, science, and technology.[2360] The perennialist-esoteric strain of syncretism is mostly resolutely inimical to Western technoscience, whereas the more modernistic 'New Age' thinkers tend to be more open to science, which they usually attempt to reconcile with New Age spirituality in some kind of personal synthesis. They are often deeply ambivalent about technology, although those touched by a large dose of environmentalism may be pugnaciously negative.[2361] On the other hand, technopagans and tech-gnostics, such as Mark Pesce, are often fervently pro-technology, although more backwards-looking neo-pagans and neo-gnostics may be as fervently against. Generally speaking, there is a bewildering plethora of different attitudes within these groups.

Modernists typically either espouse an unhesitant *fides carbonaria* as to the benevolence of technoscience, in keeping with the positivistic-scientistic tradition,[2362] or will be committed to some kind of technocritical radical, feminist, or postmodernist agenda, which usually will involve the use of a special lingo characterised by much political-philosophical *concetti,* morose sideswipes, and a plethora of politically correct announcements and denouncements.[2363] I will not be much further concerned with the writings of either category here, for which I lack the sympathy needed to assess them accurately. Apart from the greater and lesser lights of these two groups, there are also many authors who stand free from ideological commitments to these camps or attempt to find some kind of middle ground between different viewpoints.

Amongst the most influential technocritical secular philosophers will be Lewis Mumford, Heidegger, Hans Jonas, Baudrillard, and von Wright.[2364] Some authors, such as Postman, Borgmann, Heim, and, perhaps,

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2356 See [Ivan80], [Ivan91a-b], [Ivan92], [Ivan93a-b], [Ivan95], [Ivan96], [Ivan97], [Ivan00], [Ivan01], and other papers and essays available at the web page http://www.informatik.umu.se/~kivanov. See also footnote 34 on p. 9 above.

2357 See [Ross98b] and [BR99b].

2358 [Pull01]

2359 [Groo99]. Another conservative Protestant Christian critique of *cyberspace* is provided in [Broo97a], an anthology of eight articles previously published in *SCP Journal 19:4-20:1* and *20:2.* [BCBB+99], a booklet edited by a group of scientists and practitioners – somewhat oddly headed by a well-known advocate of gene manipulation – for the Church of England, also attempts to address the ethical-spiritual implications of cyberspace.

2360 See [Rosz94], [Rosz73], and [Talb95]. Cf. also [Wedd96]. Barfield, whose most influential work will be [Barf88], was a close friend of C. S. Lewis and, like him, Tolkien, Charles Williams, and various lesser prophets, a member of the famous *Inklings* group. More in the spirit of Rudolf Steiner's own fantastic, neo-Manichaean worldview, according to himself largely put together through the perusal of "the Akashic records", in which his own sinister spiritual endowments – believed by himself to be a gift from Lucifer (see [Arle96] p. 145 et seq.)! – made him so unusually proficient, are such works as [Blac81] and [Embe00], which, however, will probably strike most outsiders to anthroposophy as rather curious, as they try to connect the computer with Steiner's idea of Ahriman, an "evolutionary" spiritual power, which – in contrast to Lucifer, the "evolutionary" principle of excessive spiritual pride and self-will – represents an excessive materialism and attachment to the purely mechanical-technical (see [Arle96] p. 162). This idea of the computer as the basis for the "incarnation of Ahriman" of course has nothing to do with the canard [Anon00b] – originally published in *Weekly World News,* a notorious purveyor of phantasmagoric tales – that passed through the computer press some time ago of a certain "Rev. Peasboro" issuing warnings and writing a book about the demonic possession of computers.

2361 So, [Sale96] attempts to revive a kind of 'Luddite' Romantic environmentalism somewhere between secularism and mystical syncretism. [Dery96] maps many of the more extreme forms of technoromanticism.

2362 Some of the more extreme representatives of such views have been discussed above on p. 484 et seqq. There is also a genre of technoscientific apologetics, of which the three grim tracts for the times [Flor81], [Holt93], and [Levi99] by Florman, Holton, and Levitt provide rather typical examples.

2363 [BD94], [BB95a], [Mark96a], and [BC98] provide some examples of essays written in this awkward style. More of the kind can be found in [KW01].

2364 See footnote 2103 on p. 457. Just as with McLuhan, some of these, such as notably Lewis Mumford, went through a development from an early, technooptimistic phase towards increasing technopessimism.

Wiener, show a certain openness to spiritual-religious perspectives[2365], whereas others, such as Noble, Midgley, and Slouka, criticise the tendency to imbue technology and science with religious significance and make it into a kind of *ersatz religion.*[2366] In particular, Noble argues that technology ought to be sanitised from the millenarian dreams of transcendence that currently seem to endanger man's survival, pompously exhorting us to "disabuse ourselves of our inherited other-worldly propensities in order to embrace anew our one and only earthly existence", thus not only giving short shrift to the parlous, distorted fragments of otherworldly beliefs rampant in technoscience, but abolishing all otherworldly beliefs across-the-board and all religion and spirituality withal – i.e. the very sphere that is debased and disfigured by the technomillenarian distortions![2367]

There are also various authors who, from a secular point of view, are more specifically concerned with the ethical aspects of computing. One of the first to comment extensively on the ethical dilemmas of computing and cybernetics was Norbert Wiener.[2368] More recent secular writers taking a profound interest in the ethical aspects of computing and virtual reality include Weizenbaum, Winograd/Flores, Birkerts, Slouka, Coyne, Borgmann, Heim, Sherman/Judkins, Rochlin, and Joy.[2369] Interestingly, quite a few of these (Winograd, Flores, Coyne, Borgmann, and Heim) are more or less strongly influenced by existentialist philosophy in the Heidegger tradition.[2370] Particularly influential has been Heidegger's analysis of technology as implying an entrapping, manipulative-instrumental attitude to the world, *das Ge-stell,* (usually rendered "enframement" in English), in which everything and everyone are seen as but resources or "standing reserve", *Bestand,* to be exploited and a "frame" of objectifying, mathematical-logical descriptions and causal explanations, subservient to this exploitative mindset, is imposed on reality, concealing Being, truth, and the "thinghood" of things from man.[2371] Additionally, some agendas of computing, such as Engelbart's anti-AI agenda of "intelligence amplification" (IA), Alan Kay's anti-technocratic agenda of "personal computing," or Mark Weiser's anti-VR agenda of "ubiquitous computing", originally emerged as attempts at a critical rethinking of the current state of computing. It should also be noted that many authors, for various reasons, do not discuss – or deliberately conceal – their deepest convictions and thus may appear to be secular modernists or religiously and philosophically indifferent, although they perhaps are not.[2372]

Instead of partitioning the philosophers of technology into *traditional theists, mystical syncretists,* and *modernists*, one may arrange them according to the stance they take towards technology. To do this, we will here

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2365 Neil Postman, McLuhan's disciple and author of [Post86], [Post92] [Post93], and [Post94], is a conservative scholar sympathetic to religious traditions, but writes from a secular standpoint. Borgmann (see [Borg92] and [Borg99]) and Heim (see [Heim93] and [Heim98]), who are both much influenced by Heidegger's existentialism, occasionally touch upon spiritual-theological matters. In [Wien64a], Norbert Wiener tried to elucidate "certain points where cybernetics impinges on religion", although he largely remained caught up in the positivistic tongue-in-cheek attitude towards the life of the spirit.

2366 See [Nobl99], [Midg94], and [Slou95].

2367 See [Nobl99] p. 201 et seqq.

2368 Already in [Wien48] ethical topics were touched upon, whereas they were dealt with more fully in [Wien54] and [Wien64a]. Cf. also Wiener's autobiographies [Wien64b] and [Wien66] and the biographies [Heim80] and [Masa90].

2369 See [Weiz76], [WF87], [Birk94], [Slou95], [Coyn95a], [Coyn99], [Borg84], [Borg92], [Borg99], [Heim93], [Heim98], [Heim99], [SJ93], [Roch97], and [Joy00].

2370 See [Mitc94] p. 49 et seqq., [McLu62] p. 248, [WF87] p. 27 et seqq., [Coyn94], [Coyn98], [Coyn95a] p. 5 et seqq. et passim, [Coyn99], [Borg84], [Borg92], [Borg99], [Heim93] p. 55 et seqq., [Heim99] p. 71 et seqq., and [Heim98]. Various papers on Heidegger and technology are listed at http://www.webcom.com/paf/techlinks.html. A special issue (11:4, 1998) of *Information Technology & People* was devoted to Heidegger and computing.

2371 See [Heid74]. According to Heidegger, it is actually not technology that conceals Being, but Being that conceals itself through technology, which is not "anyone's fault". He also tends to speak of *das Ge-stell* as a kind of impersonal agency, a demonic spiritual force, which does not seem far removed from Christian ideas about the rule of Antichrist that will precede the end of the world or even from Steiner's conception of Ahriman (see [Arle96] p. 162). Cf. also [Hill88], who, after a lengthy analysis of the history and workings of "the tragedy of technology", i.e. man's escalating enframement by technology, implausibly argues that this enframement can be overcome by social action. As for the concept of "thinghood", Heidegger distinguished the soulless "product" or "object" *(Gegenstand)* fabricated by industrial technology from the genuine "thing" *(Ding),* i.e. the work of art, such as the earthen pot shaped by the craftsman or the old wind-mill or stone bridge uncovering the beauty and spiritual qualities of a landscape, famously characterising the "thing" by its capability for "thinging" or gathering together "the four", heaven, earth, the mortals *(die Sterblichen),* and the gods *(die Göttlichen).*

2372 Such apparent disinterestedness may be an escape from confrontation with those who do not share one's own point of view, but can also be more or less dictated by the genre the author is writing in. For example, a humorous lamentation of the woes of the modern life on the "information highway", such as [Stol95], may not be the proper place for profound metaphysical ruminations.

adopt a scheme suggested by Carl Mitcham in *Thinking through Technology,* his excellent survey of the philosophy of technology.[2373] In an appendix to this work, he outlines three "ways of being-with technology", to wit:

- *Ancient skepticism,* the attitude dominating Western thought up to the Renaissance, being typical of the ancient philosophers, including Socrates, Xenophon, Plato, and Aristotle, and also being undergirded by the Jewish-Christian-Islamic scepticism of worldly wisdom, riches, and power, can be summed up in the maxim "technology is bad but necessary" or further elaborated into a fourfold argument: "(1) the will to technology or the technological intention often involves a turning away from faith or trust in nature or Providence; (2) technical affluence and the concomitant processes of change tend to undermine individual striving for excellence and societal stability; (3) technological knowledge likewise draws human beings into intercourse with the world and obscures transcendence; (4) technical objects are less real than objects of nature."[2374]

- *Enlightenment optimism* refers to the novel attitude towards scientific knowledge and techno-logy that started to gestate during the Renaissance through the influence of Hermetic-occult and Neoplatonic philosophy and was codified by Francis Bacon, who subtly re-interpreted the first chapters of Genesis along Hermeticist lines so as to be able to argue

  1) that man, as the appointed master of the creation and the *imago Dei,* is to make use of his intellectual powers to become God's co-creator and control the world to his own advantage,

  2) that the essence of man's original sin is not the quest for knowledge of things hidden and forbidden, but vain and unproductive speculations on ethical questions,

  3) that scientific and technological knowledge is ethically unproblematic, nay a kind of moral imperative, and

  4) that, consequently, we do not need to be much concerned with its consequences.

  During the Enlightenment, this attitude mutated into its modern secular form, as the Her-metic-occult origin was increasingly repressed, covered up, or forgotten and the Christian varnish sloughed off. The unconditional optimism as to technoscience typical of this agenda in effect constitutes a total reversal of *Ancient skepticism* and can be summed up thus: "(1) the will to technology is ordained for humanity by God or by nature; (2) technological activity is morally beneficial because, while stimulating human action, it ministers to physical needs and increases sociability; (3) knowledge acquired by a technical closure with the world is more true than abstract theory; and (4) nature is no more real than artifice– indeed, it operates by the same principles".[2375]

- *Romantic uneasiness* is an attitude shaped by the Romantic reaction to *Enlightenment optimism* and the depredation of man and nature through the Industrial Revolution, combining in a love-hate a certain fascination for technology as an expression of human volition, imagination, and creativity with both a critical uneasiness about its consequences and a Ro-mantic-organismic, process-oriented re-interpretation of the world studied by science. This agenda can be summarised thus: "(1) the will to technology is a necessary self-creative act that nevertheless tends to overstep its rightful bounds; (2) technology makes possible a new material freedom but alienates from the decisive strength to exercise it and creates wealth while undermining social affection; (3) scientific knowledge and reason are criticized in the

[2373] [Mitc94] p. 275 et seqq. A somewhat similar scheme is suggested in [Grah00b] p. 6 et seqq., where the three categories "neo-Luddi-tes", "technophiles", and "critical realists" are distinguished.

[2374] Id. op. p. 282. The four "arguments" or conceptual elements of this scheme refer to (1) volition (transcendence), (2) activity (ethics), (3) knowledge (epistemology), and (4) objects (metaphysics).

[2375] Id. op. p. 289. The argument concerning knowledge (3) can be said to articulate a pragmatic epistemology, whereas that concerning objects (4) is typically framed in accordance with a mechanistic worldview.

name of imagination; and (4) artifacts are characterized more by process than by structure and invested with a new ambivalence associated with the category of the sublime."[2376]

Whereas the two antithetical attitudes of *Ancient skepticism* and *Enlightenment optimism* seem clear-cut enough and it will not be difficult to find advocates of either, the essence of *Romantic uneasiness* is more difficult to grasp with its paradoxes and subtleties and any latter-day advocates of it are by no means easy to identify.[2377] In particular, Mitcham's discussion of the category of the sublime and its relationship to technology is not quite limpid, but he seems to mean that, in the view of *Romantic uneasiness,* artefacts can reveal the sublime through a kind of overwhelming, pleasing fear, for which "modern technological objects and actions–from Hiroshima to Chernobyl–have tended to become a primary objective correlative". It should also be noted that when *Ancient skepticism* criticises technical knowledge for not being "true wisdom", this is done from a theological-philosophical vantage point, whereas when *Romantic uneasiness* criticises the technoscientific lack of imagination and vision, this is done from a predominantly aesthetic point of view.

Although, such "romantic" ideas may not be very common amongst today's philosophers of technology, it is evident that there is a broad spectrum of viewpoints framed with the intention to find some kind of "realistic" middle course between the extremes of nostalgic technopessimism and euphoric technoduly. Indeed, few would presently find either unmitigated *Ancient skepticism* a very practicable basis for large-scale political-economic action or the St. Vitus's dance towards Armageddon advocated by the uncompromising energumens of *Enlightenment optimism* a prudent and ethically satisfying programme, at least provided we, unlike the "posthumanists", want to preserve mankind and life on earth rather than eliminate them. But we must also consider the possibility that there is no intellectually convincing formulation of a middle course to be found, that Kant and Kierkegaard were right against Hegel when claiming that some antinomies cannot be bridged by a synthesis, which would leave us with a pointed and unsettling "enten-eller". Or even that the current "Darwinian" political-economical order of the world has been so insidiously set up so as to establish the programme of *Enlightenment optimism* firmly as an irremovable, built-in keystone of the economical-political reality presently about to precipitate an apocalyptic catastrophe, of which neither the ethically irrefragable objections of *Ancient skepticism,* nor the well-meant, but unrealistic admonitions and reform proposals of any "third way" can help us steer clear.

	ANCIENT SKEPTICISM	**ENLIGHTENMENT OPTIMISM**	**ROMANTIC UNEASINESS**
Traditional theism	Pre-modern and traditional Christianity, Eastern Orthodox 'neptic' theology (Ellul, Guardini, Lewis, Virilio, Lindbom, Sherrard, de Maistre)	Baconians, liberal theology, many Christian scientists and technoenthusiats (Dessauer, Teilhard de Chardin, Kelly, Cobb)	(McLuhan, White, Rossi, Jaki, Langan, Groothuis, Ivanov, Pullinger)
Mystical syncretism	Most ancient and Eastern philosophy/religion, some neo-paganism, anthroposophy, perennialism (Sale, Barfield, Talbott, Roszak, Blake)	Technopaganism, 'techgnosis' (Pesce)	(Dery)
Modernism	Postmodernism, feminism, radical theory, environmentalism, existentialism (Mumford, Heidegger, Jonas, Baudrillard, von Wright, Slouka, Postman, Birkerts, Joy)	Scientism, positivism, orthodox Marxism, extropianism, "cyberpunk", proponents of strong AI, AL, VR (Minsky, Kurzweil, Moravec, Mazlish, Tipler, Florman, Holton, Levitt)	(Wiener, Rochlin, Weizenbaum, Borgmann, Heim, Coyne, Midgley, Noble, Hill)

Table 3. Matrix of attitudes with some representatives

[2376] Id. op. p. 297.

[2377] Perhaps, [Coyn99] may be cited as an example where such a point of view is meditated.

How do the three "ways of being-with technology", *Ancient skepticism, Enlightenment optimism,* and *Romantic uneasiness* relate to the three main strands of current Western thought – *traditional theism, mystical syncretism,* and *modernism* – we just discussed and associated with the ethical stances of *strong value objectivism, weak value objectivism,* and *value subjectivism? Prima facie,* one may perhaps be tempted to think that there is a one-to-one relationship between these, where *traditional theism* goes with *Ancient skepticism, modernism* with *Enlightenment optimism,* and *mystical syncretism* with *Romantic uneasiness.* Although this suggestion certainly reflects the fundamental affinities, it is not a truthful representation of the whole gamut of actually existing viewpoints. Rather a matrix will be needed in order to represent all the possible combinations (see *Table 3).*

Firstly, it should be noted that as *Romantic uneasiness* is a somewhat fuzzy category, which lacks clearly discernible agendas, the thinkers assigned to it are such as seem to reside somewhere between the extremes of *Ancient skepticism* and *Enlightenment optimism.* Since they may in actuality hold quite diverse views, which will in most cases be underpinned by pragmatic rather than "romantic" considerations, a more fitting term would perhaps have been *Pragmatic uneasiness,* although I have chosen not to upset Mitcham's choice of terminology. Secondly, it should be pointed out that some authors are not very clear about their deepest philosophical and theological views, have changed their views over time, or may arguably belong to more than one category. In some cases, one may also ask if an agenda has not been misplaced altogether. In particular, liberal theology is arguably more modernist than traditionally theistic, although it is here treated as a kind of theism.

Since I am not here trying to provide an exhaustive or even representative survey of all conceivable and existing points of view on these matters, I will from now on concentrate on the viewpoints, from which I personally believe some guidance and wisdom can be garnered. So, I will skip the standpoint of *Enlightenment optimism,* which today seems to have lost all credibility and plausibility – to the extent that it ever really possessed any – through the ramifications of its own implementation, the main features of which are observable everywhere around us and so well known that it seems to be a work of supererogation even to mention a few of them again, such as the destruction of the beauty of nature and the human habitations, the terrors of modern warfare, the environmental disasters, the homogenisation of all cultures into an ugly, rebarbative global technoscientific uniformity, the corresponding ideological poisoning of the spiritual life of the nations and assault on religion, piety, the *Tao,* family life, the quest for virtue, and all that is really valuable and worth protecting, just to name a few of the innumerable evils brought about by the cancerous technoscientific 'progress' that has reigned supreme all since the Enlightenment and the Industrial Revolution and proceeds at an increasingly maddening pace for every year that passes by. We have referred to Voegelin's thesis about the gnostic roots of this agenda repeatedly above, and, indeed, those who still stick to *Enlightenment optimism* unreservedly often seem to have something 'gnostic', 'possessed', or 'demonic' about them, as though they were pursuing a distorted or pathologic form of spiritual quest rather than openly and sincerely searching for the truth about God, being, and man and a serious and realistic understanding of man's current plight. By the same token, I have argued at some length that *modernism* is a similar illness of the Western mind, propped up by metaphysical presuppositions that are not only dubious, but also demonstrably false. Having stepped out of the *Tao,* the modernists infallibly end up in ethical subjectivity and arbitrariness and seem doomed to wander around forever in the labyrinth of their own nihilism, a labyrinth without either centre or exit. Yet, some of the modernist technocritics and romantics do have interesting things to say, although their overall conception of the world by necessity remains flawed by the aberrant perspective that follows from the abolition of the *Tao* and the negligence or flat denial of the most important portions of existence – that is to say, in Scheler's conception, the realms, to which *Wesenswissen* and *Heilswissen* pertain.

Much of the thought that falls in the category of *mystical syncretism* is liable to kindred criticisms. For one thing, many syncretists enthusiastically and uncritically embrace the very Gnostic and occultist thought structures, which, in our view at least, are the sources of most of the vices of both *modernism* and *Enlightenment optimism* in the first place, whereas others, in a gesture of gnostic-Romantic sedition, fatuously and artificially try to revive some strain of long-forgotten paganism, thereby typically ending up in very contrived and at times debilitating religious posturing that, as argued above, easily degenerates into a kind of paradoxical counter-cultural hypocrisy. Others, reacting against the scandal of religious exclusivism and trying by all means to avoid the Scylla of dogmatism, instead get trapped in the Charybdis of exceedingly credulous openness, becoming unable to find a spot of firm ground to rest their feet on or going astray in the slough of sectarianism, personal heresy, faith hopping, vague mysticism, and a parlous and often deeply demoralising craving for unusual 'experiences'. Although the above criticisms will not apply to all factions of this very inhomogeneous group, it seems fair to say that, by and large, most mystical syncretists tend – whether by their

shilly-shallying or by their gnostic rebelliousness – to weaken or undermine the *Tao* without giving it up altogether. Still, many of them, in particular those of a technosceptical bent, have – partly by virtue of their openness – made significant and thought-provoking contributions to the discussion on technology and, as there has been considerable interaction in the past between this group and 'traditional theists', there seems to be room for constructive dialogue in the future as well.

Thus having provisionally ruled out both *modernism* and *mystical syncretism* as viable alternatives for ethical guidance, we are left with *traditional theism,* of which we will primarily explore the two varieties *Ancient skepticism* and *Romantic uneasiness,* as the standpoint *Enlightenment optimism* is, in our contention, at odds with basic theistic perceptions for reasons that will soon be clear and its appearance within Christianity was, as we have tried to show above, mainly a consequence of extrinsic, occult-Hermetic influences.[2378] Let us start with the standpoint of *Ancient skepticism,* i.e. the strong questioning of technology, as it arguably will be the most natural *theistic* point of view, for a number of theological reasons, which will now be considered. Before doing so, I should just like to emphasise that I will not – and indeed, considering the character of the issues at hand, cannot – censor what follows out of respect or trepidation for those who consider themselves too sophisticated for theistic, Christian, theological, or religious arguments, dismiss such forms of reasoning as "unscientific", "subjective", "arbitrary", or "outmoded", or should like to stamp out and silence all Christian or otherwise religious voices in Academe. Indeed, it can be argued that anyone who makes such claims is himself quite unscientific, subjective, arbitrary, and outmoded. This said, *in medias res!*

Firstly, according to the well-known account in the first chapters of *Genesis,* this world, albeit originally "good", is now a fallen one, being under the curse which God put on the ground due to man's original sin.[2379] In the Jewish-Christian conception of these events, the fall from the Edenic state is not just a vague symbol for man's faultiness. Rather, it is to be understood as the key event in history bringing the present order of the world into being through a very material deterioration of the original creation, as the Fall not only corrupted man morally, but disfigured pervasively, in an ethico-ontological sense, as it were, the entire creation – heavens and earth – into something far inferior to what it was originally, as well summed up by St. Paul's exclamation about the world-order that ever since has prevailed, "the whole creation groaneth and travaileth in pain together".[2380] For one thing, death was brought about by the Fall, not being part of the Edenic order of things, which, thus, was very substantially different from the present order of the world. Additionally, God originally gave unto man the seed of the herbs and the fruits of the trees as food and unto the animals the green herbs. Only after the fall, when the first couple had been clad in "coats of skin" by God and the initial "goodness" of the created order had been significantly diminished, the creatures took on their current carnivorous habits, later to be confirmed in the postdiluvian covenant God made with Noah.[2381]

Subsequent to the Fall, the mores of men rapidly grew worse, apparently – at least partly – due to the iniquitous influence of the fallen angels, the "sons of God" and their giant offspring, until God, seeing "that the wickedness of man was great in the earth, and that every imagination of the thoughts of his heart was only evil continually"[2382], decided to put an end to all this depravation through the Flood. After the Flood, God instituted a covenant, first with Noah, and later with Abraham and Moses, but this was largely a compromise making many concessions to man's and the world's fallen nature, as repeatedly emphasised in the narratives of the Pentateuch. Only through the coming of the Messiah, foreboded by the Israeli prophets, will the restoration of the Edenic state begin.[2383] According to the Christian faith, Jesus of Nazareth was the Messiah, as ultimately confirmed by His unique and well-attested Resurrection from the dead. Jesus Christ, having

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[2378] Here, I will intentionally use the term *traditional theism* rather vaguely. Primarily, I use this term to refer to traditional, "orthodox" forms of Christianity (i.e. Roman Catholicism, Eastern Orthodoxy, and Lutheran Orthodoxy), but mostly what is said will obtain also for many other forms of Christianity and largely also for the conservative branches of the Jewish and Moslem religions.

[2379] Although the Koran recounts how Adam and Eve were banished from the Paradise to the Earth due to their transgression of Allah's command not to eat the forbidden fruit, Islam does not accept the notions of the "fall of man" and "the original sin", but holds that Allah forgave the first couple their lapse and that man is capable by himself to lead a righteous life and, thus, is in no need of redemption.

[2380] *Ep. Rom. 8:22*

[2381] See *Gen. 9.* On how to interpret the changes brought about by the Fall theologically, see also [Nell87] p. 43 et seqq., [Faiv96] vol. I p. 90, and [Will48] p. 112 et seqq.

[2382] *Gen. 6:5*

[2383] See e.g. *Is. 11:1-9, 65:17-25.*

conquered death and recovered by his Resurrection the original Edenic *corpus gloriosum,* as foreshadowed by the Transfiguration on Mount Tabor, thus initiated the process of the regeneration of the entire creation.

Secondly, due to this regeneration the present earth and heavens are, according to the Jewish, Christian, and Moslem belief expounded in the *Revelation of St. John* and various other passages of the Bible, eventually to be destroyed by fire in the course of a series of dramatic apocalyptic events, which will lead up to the creation of a new earth and new heavens. Additionally, Christ testifies Himself that His kingdom, which He refers to as the "kingdom of heaven" or "kingdom of God", is *not* of this world, for which only doom and destruction await, but inside men. The Edenic state can, according to the Christian faith, only be restored through a new creation of the Heavens and Earth by God's ruling and by the regeneration of man from inside through the workings of the Holy Ghost. As the current world approaches its end, the only goal worthwhile to each several man will, thus, be to struggle for his own and his fellow-men's salvation and to society in its entirety to attempt to promote this noble struggle by all means.

Thus, from a theistic point of view, it would not only be foolish and futile, but indicative of a fundamental misconception of the meaning of human history to attach one's hopes to technoscientific activities intended to artificially restore man's prelapsarian perfections *in the fallen, present world.* Thus, man's hopes ought to concern not this world, from which he is shortly to depart anyway, but the other (post-mortem) world and, in particular, the (post-apocalyptic) world to come, in which something like the Edenic state of beatitude will, the theist trusts, be regained. In this perspective, the thrust for innerworldly salvation through science, technology, wealth, politics, etc. appears as an entirely mistaken approach, nay a distortion of the theistic conception of eschatology and hope for a divine regeneration of the creation, leading to a progressive exacerbation of man's fallen state and, in the end, towards a complete loss of truth, sanity, and hope. Only on the basis of the heretical Gnostic depreciation of God into either a bungling, evil Demiurge or an impersonal world-ground/set of laws and the Gnostic-Hermetic celebration of man as a blameless terrestrial god, will it appear reasonable to claim 1) that the world is so imperfect that it needs to be 'fixed' by man to his own advantage and 2) that man will be capable of such a feat of correcting the order of being. But from a theistic point of view, such beliefs will appear as silly and profoundly mistaken daydreams apt to destroy the ethical basis of society and fill man with pride and lowly desires, as a way to keep him busy with futile projects that distract him from his most important task in this world, to wit the turn towards God, the struggle for the transformation of his own heart through the love of God, and, ultimately, the salvation of his own soul.

Apart from this general Jewish-Christian pessimism about man's capability for the good and the character and prospects of the present world, there is also an implicit critique of technological 'progress' in the Biblical account of antediluvian history recounted in the first chapters of *Genesis.* Here the impious descendants of Cain, himself the first man to cultivate the earth, slay another man, and build a city, are depicted as innovators, who invented polygamy (Lamech), tents and cattle-breeding (Jabal), harp and organ (Jubal), and metal-working (Tubal-cain, "an instructor of every artificer in brass and iron"[2384]), whereas the descendants of Cain's devout brother Set are credited with no innovations, but are instead described as inclined towards piety, as, for example, Enos, in whose times "began men to call upon the name of the LORD"[2385], the mysterious Enoch, who – in contrast to Cain, who "went out from the presence of the LORD"[2386] – "walked with God: and he was not; for God took him"[2387], or Noah, who also "walked with God" and "was a just man and perfect in his generations".[2388] However these scraps of historical records are to be construed, they seem to imply an astonishingly explicit disavowal of inventions, novelty, and "progress", which are associated with moral corruption and counterposed to a pious life in communion with God. The account of the Tower of Babel is similar in tenor, strongly emphasising the divine displeasure with man's presumptuous technical impetuosity.

2384 See [Ellu70].

2384 *Gen. 4:22*

2385 *Gen. 4:26*

2386 *Gen. 4:16*

2387 *Gen. 5:24*

2388 *Gen. 6:9.*

Although this is barely hinted at in the Biblical account, the (first) *Book of Enoch,* which seems to have been rather widely studied in the early Church as witnessed both by allusions to it in the New Testament, including a direct quotation in the epistle of St. Jude, and in the writings of the Fathers[2389], but is now held to be a pseudepigraphic composition written in the intertestamental period, also associates various dubious inventions with the fallen angels referred to as *bene Elohim,* the "sons of God" (so *Genesis)* or *irin,* "the watchers", who were also reported to have begotten with "the daughters of men" the blood-thirsty race of the giants, the *Nephilim,* the "mighty men which were of old".[2390] According to the *Book of Enoch,* these "watchers", led by Azazel, the fallen angel to whom one of the two "scapegoats" was to be sacrificed according to *Leviticus*[2391]*,* revealed unto men, to their great detriment, the secrets of magic, astrology, alchemy[2392], herbs, signs, divination, etc. and taught them magical medicine, incantations, the cutting of roots, "the blows of death", "the smashing of the embryo in the womb", astronomy, the art of writing, and the art of deception as well as how to make swords, knives, shields, breastplates, bracelets, jewellery, cosmetics, etc. Despite its apocryphal character, this account certainly properly reflects the Jewish and Christian distrust of such occult-technological "advances", considerably reinforcing the attitude of *Ancient skepticism* already present in the Biblical account of mankind's early history.

In traditional Christian exegesis, which is based on the older Jewish exegetical practices used also in many places in the New Testament and later absorbed in Moslem Koran exegesis as well, *typological* interpretations of paradigmatic situations and stories from the Bible and the history of the Church have often been relied upon to get a cue about how to act in a certain situation, which is not accounted for by any direct Scriptural commandment or parallel story. Although such analogical understanding is likely to get up the hackles of the despisers of religion and theological models of reasoning, it will be indispensable for anyone who wants to come to terms with ethical quandaries, *provided,* of course, that one accepts the Christian (or Jewish, or possibly Moslem) premise of their validity. The discussion below will partly rely on such arguments without trying to verify their validity.

If typological arguments are allowed for, many models for the attitude of *Ancient skepticism* can be extracted from both the Bible and the history of Christianity, bearing out how, in order to be able to devote themselves to the pursuit of God and obey His will properly, men of a pious bent have repeatedly made the conclusion that they had to make a radical break with an ambience that for various reasons had taken on a dubious character – be it through some kind of idolatry, excessive materialism, superficial rationalism, moral wickedness, or some other cumbersome ill – or tried to impose iniquitous or distracting demands on them.[2393]

[2389] See [Char1893] p. 38 et seqq.

[2390] See *Gen. 6:4*. According to another interpretation of this passage, the "sons of God" are rather to be understood as the descendants of Set, whereas "the daughters of men" were the descendants of Cain (so, for example, [Arch82] p. 79 et seq.). Despite a certain popularity in early Christian circles, the *Book of Enoch* was not regarded as genuine, truly inspired, or canonical by most Fathers and soon began to fall into disrepute. It was finally rejected together with other apocryphal and pseudepigraphic works at the Council of Laodicea in 363 and thereupon gradually passed out of circulation except amongst the Coptic Christians of Ethiopia, where the book was absorbed into the canon and has remained influential to this day. Through the intermediation of Guillaume Postel, who was apprised of its contents by an Ethiopian priest resident in Rome (see [Bouw57] p. 36), a certain curiosity about the mysterious *Book of Enoch* was aroused in some circles during the late Renaissance, reflected, for example, in the writings of such figures as John Dee and John Milton (see [Will40]). Three manuscripts of it were finally recovered in 1773 from Abyssinia by the Scottish explorer and freemason James Bruce, but it was not translated into English until 1821. Today, good English translations, such as [Char1893] and [Char83] vol. I, are easily available.

[2391] See *Le. 16:5-10.* Many exegetes prefer an alternative vocalisation of the Hebrew of the crucial passage, which then can be rendered as "a goat of departure", without any reference to Azazel. According to a Jewish-Moslem legend, Azazel was cast out of heaven because of his refusal to bow down before Adam. See [Davi71a] p. 63 et seq.

[2392] Cf. [Pata94] p. 18 et seqq. According to the famous alchemist Zosimus, who lived in the 3rd or 4th century A. D., the watchers even committed their alchemical secrets to writing, authoring a book *Chema,* from which alchemy derived its name.

[2393] For example, many early Christians became martyrs, as they refused to worship the Roman emperor's genius, and more lately Christians have been persecuted, tortured, and killed *en masse* for their refusal to compromise with communism and other anti-Christian political movements. We admire St. Maximilian Kolbe, Dietrich Bonhoeffer, and Jehovah's Witnesses – despite their dubious theology – for their courageous steadfastness against the National Socialists, whereas we are appalled by the servility of groups such as Deutsche Christen. Likewise, the Catholic and the Eastern Orthodox Churches have commanded growing respect for their firm stance against modernism, "the worst of all heresies", whereas Protestantism has lost much in credibility through its cowardly compromises and surrenders to the state, political and scientific trends and threats, and suchlike. Many Biblical models for the radical, uncompromising rejection of evil and falsehood in their various forms may be found, including first and foremost of course Christ's martyrdom on the Cross, but also, for example, Israel's exodus from Egypt, the dauntless evangelisation of the first Christians in the face of the greatest dangers, St. Stephen's martyrdom, and many other events and episodes of a similar character.

Notably, Eastern Orthodox theologians, emphasising the necessity for vigilance against foul influences and impulses, occasionally complain that Western Christianity lacks a *neptic* theology, i.e. a theology of sobriety, which might, they contend, have inoculated it against many of the gnostic follies characteristic of modernism and technoscience.[2394] Similarly, in the world of Islam the great Persian philosopher and theologian al-Ghazzali (1058-1111), known as Algazel in the Latin West, more or less put an end to the irreligious strains of philosophic-scientific speculation through his *Destructio philosophorum (Tahāfut al-falāsifa)* and laid the ground for a "revival of the religious sciences" based on a philosophically tinged Sufi mysticism, which has remained influential in the Moslem world to this day, although it has largely been eclipsed by more activist forms of Islam during the last century.[2395] His defence of religion against the onslaught of philosophic rationalism in many ways parallels that of St. Thomas Aquinas in Latin Christianity, but made fewer concessions to philosophy and, in the end, proved more effective. Most importantly, al-Ghazzali managed to disinfect Sufi mysticism from much of the Gnostic-antinomian perversions and follies that attached to it and, from a Moslem point of view, guided it into more orthodox conduits. Despite the attempts of the Catholic Church and its great theologians to domesticate the onagers of rationalist Neoplatonic-Aristotelian philosophy and Gnosticising mysticism and occultism stampeding into the West from the Moslem and, to a lesser degree, Byzantine worlds from the 12th century onwards, the story line was to unfold in a much more freewheeling and, in the end, noxious manner in the Latin West.

If we try to translate the theistic attitudes of yore discussed above to the present-day domains of science and technology, the *theistic* variety of *Ancient skepticism* would arguably not only imply a refusal to implement and publicise scientific and technical ideas that will be to the obvious detriment of mankind or will create unnatural moral quandaries, but an imperative duty to analyse, besides the more material consequences of an idea, also its *spiritual, ethical,* and *esthetical* ramifications "neptically" *before* even considering implementation and publication of the idea in question. In case of doubt, or perhaps rather by default, the status quo is to be opted for. Thus, the theistic-skeptic engineer or scientist should emulate the restraint of earlier times, as exemplified by – as we will soon see – Archimedes, Leonardo[2396], and, in particular, all those unknown researchers, who, held back by their own scruples, kept their ideas and hunches to themselves or chose not to develop them at all, rather than the unrestrained curiosity, publicity-searching pride, greed, and insensitivity to the consequences of their pet-interests typical of the model heroes of modern technoscience. From this point of view, *secrecy,* all but universally cherished by those privy to important knowledge up to "the scientific revolution", is once again to be held up as a virtue, not a vice.[2397]

As pointed out above, *Ancient skepticism,* albeit perhaps looking quaint in an era, when, for all the talk about environmental concerns, the cant praising technoscientific achievement and "progress" as mankind's destiny or only hope has become more deafening than ever, was widely embraced in the past and will arguably be a much more natural and reasonable way to approach innovation and change than the extreme neolatry of the modern and postmodern world. Although the attitude of *Ancient skepticism* started to lose its supremacy in Western Europe during the Renaissance and was almost obliterated by the extreme propaganda of the prophets of the Enlightenment and the various subsequent forms of progressivism and positivism, a few eminent latter-day theistic critics of science and technology, such as Samuel Johnson, Joseph de Maistre, and Jacques Ellul, have cultivated an attitude that can be characterised as close to *Ancient skepticism.* The current plight of the world, itself a consequence of the spell of *Enlightenment optimism,* will by necessity make this position seem more relevant than ever and, perhaps, the only ethically defensible one.

Although arguably the most appropriate theistic attitude to technoscience will thus be one of hearty scepticism, emphasising both the spiritual-ethical and the physical dangers of the unreflecting acceptance of technical change, this basic attitude does not necessarily imply that all technoscientific activity is to be condemned or prohibited. For one thing, much needs to be done to counter or diminish the harmful effects of

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2394 Cf. [BR99b]. On the other hand, the theology of "discernment" cultivated in the West partly fills the same need (see [Duba97]). See also [Schl61] p. 65 et seq.

2395 [Algh97]. Translations of some of his writings as well as various articles dealing with his philosophical and theological views are available at http://www.muslimphilosophy.com/gz/default.htm. [Corb93] p. 179 et seqq. points out that al-Ghazzali's destruction was efficient mainly within Sunni Islam, whereas philosophy continued to prosper in Shiite Persia. Cf. also [Watt63], [Bell89], and [Elia78a] vol. III p. 130 et seqq.

2396 See p. 521 below.

2397 See [Eamo90] and [Eamo94].

the technoscientific assault on the world, the enormous environmental, esthetical, and spiritual pollution of our world, and some of the countervailing measures must by necessity be technoscientific, although it should be kept in mind that such measures will, from a theistic point of view, be bound to fail if they remain stuck in the purely instrumental outlook of today's technoscience and do not take into account the divine and spiritual foundation of the world as well as the ethical-esthetical restrictions flowing from it.[2398] Furthermore, Christianity has historically been quite pragmatic about the existing world and, whenever possible, tried to turn also the questionable or bad into something good, sanctifying it, as it were, by imbuing it with Christian faith, hope, and charity. As man *de facto* exists in the present imperfect world and cannot break out of the current order of things, as the Gnostics believed, he has to make the best of it at the same time as he makes every effort to sustain his own and others' spiritual health and to avoid increasing the evil and suffering in the world. Obviously, technoscience cannot be given up or abolished – least of all overnight –, nor history be undone or man be made to suddenly travel backwards in time to a state of imagined Edenic perfection, as sure as man cannot give up food and drink. The attempts at creating an *immanent* Paradise along the lines of Rousseau's primitivism, the attempted inversion of the original sin, will not only appear as exceedingly fatuous to the theist, as Paradise, from which man was after the Fall shut off by "Cherubims, and a flaming sword which turned every way"[2399], is not a state that can be attained within this fallen world or be brought about by man, but – quite logically – tend to end up in the forbidding barbarities of the Killing Fields and kindred gruesome quests for the fata morgana of "year zero".

Notably, when St. John the Baptist was asked by the soldiers, who came to him, what they should do, he did not tell them to give up warfare, but answered, "Do violence to no man, neither accuse any falsely; and be content with your wages".[2400] In this world, man cannot hope to put an end to war, crime, illness, and starvation, nor to domesticate technology and science, but he may try to minimise their adverse effects by prudence, to sanitise them of their worst excesses, and to sanctify what is not incorrigible by trying to add to it as much of grace, faith, hope, and charity as he can with God's help. The despisers of Christianity have – all since Antiquity – often attempted to undermine its credibility by pointing out various alleged heathen forerunners of Christian practices and conceptions, such as the reverence shown to the Saints and to the Mother of God or the notions of Logos, the Holy Trinity, the Incarnation, etc.[2401] Although much of this on closer scrutiny seems unconvincing, biased, and exaggerated, the existence of some such parallels was well known to the Christian Fathers, who, however, used to interpret them as due to the preparatory work of the Divine Logos amongst the heathen, paving the way for Christianity. In this vein, early Christianity tried to, as it were, absorb, purify, and sanctify what it found useful and reasonable as a *praeparatio evangelica* in pagan culture, and this mind-set has largely prevailed through the ages. As a recent, albeit perhaps somewhat frivolous and trifling, example of this overriding Christian effort to sanctify a pagan world, one may cite the Holy See's appointment of St. Isidore of Seville as the patron saint of the Internet. In any case, an attitude of *Romantic uneasiness,* or perhaps rather *Pragmatic uneasiness,* can also be said to be part of the traditional theistic attitude to technology and science as well as to human culture in general.

Yet, there are clearly cases when there can be no question of compromising. Has technoscience at large become, or is it on the verge of becoming, such a radical evil that the theist should turn his back on it altogether? Or is there still hope for a re-sanctification? Certainly, much that goes on under the auspices of modern science and technology seems highly questionable from a theistic vantage point. For one thing, I have argued above that Darwinist biology is a nihilist cancer of untruth, with which a Christian can make no compromises. Likewise, the ethicality of what presently happens within genetic engineering, nanotechnology, and other varieties of "extreme science" seems exceptionally questionable.

With the aforementioned matrix of the three main Western outlooks and three ways of being-with technoscience in mind, I will now very briefly contemplate the following three issues:

[2398] Cf. [Ehre81].

[2399] *Gen. 3:24*

[2400] *Ev. Luc. 3:14*

[2401] J. G. Frazer was perhaps the foremost representative of this anti-Christian fad.

1) the character of the factual effects of the adoption of new technologies

2) the shifting historical attitudes to the adoption of technology

3) the probable effects of a large-scale adoption of the technologies of cyberspace and virtual reality

Having looked into these topics, I will try to draw a – by necessity essentially personal – conclusion as regards the ethical standing of the agenda of realistic computing.

That the modern world is in a permanent state of uproar due to the disruptive effects of science and technology and has to undergo the recurrent shock waves of all kinds of unanticipated effects, which emerge from the never-subsiding influx of innovations, is such a trite observation that one hesitates to put it in print yet another time. Still, these unanticipated effects are often baffling. For example, it has been argued that the adoption of such a seemingly innocent device as the stirrup at the beginning of the Middle Ages laid the foundation for the feudal society.[2402] A recent book on the implications of virtual reality starts out by enumerating various inventions, the beneficence of which were more or less taken for granted by their originators, but which spelt unheard-of evil for mankind, such as the Chinese alchemist Ko Hung's (supposed) invention of gunpowder, which, originally lit upon during a quest for the elixir of life[2403], many hundred years later would give birth to new kinds of terrible weaponry, Gutenberg's printing press, which would undermine the very Biblical piety Gutenberg wanted to promote and help to spread the vicious anti-Christian ideas of Nietzsche, Lenin, Darwin, Hitler, and their likes, Benz' explosion motor, which would buy man mobility at the cost of environmental disaster, devastation of landscapes and townscapes, and the mayhem caused by traffic accidents, the Wright brothers' aeroplane, which, also in the interest of human mobility, would horrendously multiply the terrors of war, in particular for innocent civilians, or the nuclear physicists' curiosity-driven forays into the nature of matter, which gave us bombs with the power to annihilate mankind and life on earth altogether.[2404] When a new technology is under gestation its supposed positive effects are usually much amplified and embroidered by those working on it in order to secure funding and good publicity, whereas the negative effects are either not understood, downplayed, or brushed aside as insignificant or uninteresting. Regularly, the harmful consequences will then turn out to be much greater than anticipated and, regarded in perspective, in many cases will tend to overshadow the boons altogether.

Thus, if history advises us to be extremely cautious before we accept new technology and there is a widespread awareness that prior assessment of research agendas is badly needed, it may seem strange that today hardly any checks on technoscience exist at all and that those there are – in the form of ethical committees and suchlike – seem to be devoted rather to the alleviation of bad conscience – if such a thing is still with Western men after more than 200 years of nihilistic campaigning to root it out – than to adequate measures against dubious or aberrant forms of research. Indeed, as pointed out by Virilio in the epigraph, one may even question if it is meaningful to try to draw a line between the "dubious and aberrant" and the "innocent", as today arguably no innocent science will exist at all. The value subjectivism predominating amongst scientists no less than in modern society at large also comes in handy here – if there is no right and no wrong, anything will become acceptable, if only we get accustomed to the thought of it. In any case, not only will any proposal for ethically motivated restrictions on the freedom of science and technical invention be likely to be greatly resented by the scientists and engineers concerned and to be denounced as starry-eyed, preposterous, or backwards by their cheering crowds, but the very Darwinian nature of the modern world, where competition between states, political parties, companies, 'interest groups', and individuals for power and profit, the unholy trinity of "Krieg, Handel, und Piraterie"[2405], makes it virtually impossible or, at the very least, extremely difficult to control research, which will provide substantial benefits and gains to whomsoever will first be able to take advantage of it. And even if, against all likelihood, some kind of global control system for technoscience could be established, we can rest assured that the next great war would make this system collapse immediately. Thus, besides lack of funding, incompetence, and unrealistic ideas, the only checks there

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[2402] So [Whit62] p. 1 et seqq. and [Whit78] p. 278 et seqq., although the survey of research made by [Sloa94] divests White's thesis of some of its credibility. Cf. also [SH63].

[2403] Cf. [Coud80] p. 183 et seq.

[2404] [SJ93]. Cf. also [Tenn97] and [Grah00b] p. 39 et seqq.

[2405] [Goet77] p. 324 (2. Teil, 5. Akt)

are will be the conscience of the individual scientist or engineer, who still has the power to hold back his own ideas, although the probability of someone else's hitting upon them sooner rather than later will in most cases make such self-restraint more praiseworthy than effective.[2406]

The current state of affairs may be contrasted with the way new technology was adopted in pre-modern times – and indeed by all cultures other than the modern Western one, which is presently about to grow into a single global monoculture.[2407] During the entire epoch of classical Antiquity with all its admirable feats of literature, architecture, art, and philosophy, there was almost no significant technical innovation that came into widespread use, although some intriguingly ingenious devices indeed were made, as the unique find of the ancient 'computer' of Anticythera bears witness to.[2408] Amongst the ancients, novelty was mostly regarded with great suspicion, technology was not highly esteemed, and history was generally construed as a process of decline rather than as one of progress.[2409] Plutarch provides us with a good example of this mindset, when he, in the *Life of Marcellus,* recounts how Archimedes was too high-minded to depart from the heights of mathematical abstraction to the lowly task of technical invention except when his own hometown Syracuse was in great military danger. Then, he, however, took care not to commit to writing the embarrassingly banausic pieces of knowledge he had arrived at for such practical purposes.[2410] Many Greek myths, such as the well-known stories about Prometheus, Daedalus, Icarus, king Midas, or Hephaestus, reflect a similarly dismissive, condescending, or at least deeply distrustful attitude towards technological inventiveness and the ignoble greed, power fixation, and hubris that it articulated in the eyes of the ancient Greeks.[2411] In the Bible as well as in some other early Jewish literature, such as the *Book of Enoch,* we also find reflections of a similar outlook, as pointed out earlier. The doubt about the benevolence of technological innovation largely retained its grip amongst the educated at least until the Renaissance and in the popular mind well into the 19th century. For instance, Leonardo da Vinci "by reason of the evil nature of men" chose to keep his own ideas and drafts of the submarine secret, as owned by himself in the famous *Codex Leicester.*[2412] And in 1579, the inventor of a weaving machine was condemned to be strangled by the Council of Danzig, as his machine was perceived to threaten the social order of the city.[2413]

However, already during the early Middle Ages the animosity to technical change slowly began to decompose, as can be seen from the rapid assimilation of a series of new contrivances during the Middle Ages, such

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[2406] One case that possibly illustrates the points at issue is the atomic bomb. After the war, Heisenberg, the head of the German atomic bomb project, claimed that the reason why the Germans never succeeded in making a bomb was that the scientists involved in the project did not want to provide the Nazis with such a terrible weapon. This assertion met with widespread incredulity at the time, but has recently been supported in the lengthy monograph [Powe94], the thesis of which, however, has also been vigorously disputed in another recent study [Rose98b].

Whatever the truth of this matter may be, there seems to have been little stonewalling at the other side of the Atlantic, where the Manhattan project ensured that the blessings of atomic power, this fine feat of science and engineering, was not withheld from mankind and the Communist agents involved in the work took care of their rapid diffusion to Stalin and the Soviets as well (see [KHF95] p. 205 et seqq. and [WV99] p. 172 et seqq.). Many of the scientists involved in military projects during the World War were later to regret their willingness to help in such matters bitterly. For instance, Einstein, who in spite of his pacifism had supported the idea of making a bomb by the famous letters he sent to Roosevelt in 1939-1940 and also had been involved in some of the theoretical work on the bomb (see [Clar99b] p. 659 et seqq.), is reported to have said on different occasions after the war that if he had known the ramifications his ideas were to have, he would rather have become a "watchmaker", a "locksmith", or a "plumber". Likewise, Norbert Wiener in 1947 made a public vow never to publish anything that could be useful for military purposes (see [Mitc94] p. 283) and many other scientists tried to do penance by engaging themselves in various pacifistic and altruistic projects.

[2407] See [Mitc94] p. 277 et seqq.

[2408] See [Soll59] and [Bolt84a] p. 15 et seqq. Cf. also [Turn97] p. 115.

[2409] The conception of limitation pervades all aspects of ancient culture, as Spengler saw, when he shrewdly made the extended body with its clear-cut limits the *Ursymbol* of the ancient "Apollonian soul", but chose infinite space as the *Ursymbol* for the modern Western "Faustian soul" and the cave for the Arabian "Magian soul". See [Spen97] p. 234 et seqq.

[2410] *Plu. Marc. 17*

[2411] The stories in question are recounted in the common mythological handbooks, such as [Rose59]. On the Prometheus myth, see also [Ragg58], [Duch74], [Wutr95], [Krei94], and [Keré97].

[2412] [Leon80] p. 118 et seq. (22 verso). Somewhat ironically, *Codex Leicester* (also known as *Codex Hammer),* which is reportedly the only privately owned Leonardo manuscript, was purchased in 1994 at Christies in New York by Bill Gates for 30.8 million dollar, the highest price ever paid for a manuscript.

[2413] See [Mazl93] p. 68

as the clock, the compass, the spectacles, diverse new materials and chemicals, including paper and gun-powder, and various agricultural novelties, of which the water and wind mill will be particularly significant.[2414] Still, in the popular mind of this epoch invention and mechanical devices were regularly associated with magic and the illicit trafficking with diabolic powers, and many of the medieval inventors and intellectuals were widely held to be dabbling in the black arts – often on good grounds.[2415] The foremost medieval proponent of the experimental method in science and the use of technology to gain power over nature was the 13th century Franciscan monk Roger Bacon, who, having steeped himself in the enormously popular "books of secrets" and the vast literature on the occult sciences of alchemy, astrology, and magic as well as in the fad of Joachitic prophecy bolstered by the Franciscan spirituals, tried, as the first of a seemingly never-ending succession of technomillenarians, to formulate a programme of technological development and even attempted – albeit unsuccessfully – to gain the support of the pope for this project so as to make the Christians better prepared for the coming battle against Antichrist.[2416] Yet, Bacon, in his *Epistula de Secretis Operibus* (or *Magical Letter),* where he made the famous remarks about the use of gunpowder and the feasibility of constructing aeroplanes, automobiles, submarines and various other machinery, also made an extensive plea for secrecy and even taught various methods (ciphers, shorthand, etc.) useful to assure it, illustrated by a puzzling description of the alchemical recipe for "the philosopher's egg".[2417] Inspired by the writings of the 9th century Arab Neoplatonist al-Kindi on the operations of stellar influences[2418], Bacon and some other prominent Schoolmen, such as William of Auvergne and Albertus Magnus, also began to make a distinction between admissible *natural* and sinful *diabolic magic* – a distinction which was to become increasingly important over time.

The Renaissance Hermeticists continued, albeit not altogether successfully, these attempts to whitewash the unpalatable connotations of the by themselves so rapaciously pursued *occult sciences,* which were only later more efficiently expurgated from the gloomy aura of black magic and demonolatry and welded together with the interests of state power by Francis Bacon and the other *buccinatores novi temporis,* who, thus, transformed *the occult sciences* into *science.* During this process of transformation, the Hermetic conceptions of *sympathy*[2419] and *natural magic* were – together with the closely related astrological notion of regular, lawful celestial influences on mundane events[2420] – instrumental in the formation of the modern scientific conception of the *laws of nature.*[2421] Likewise, the experimental method of science developed out of the practices of the magicians and alchemists.[2422] In the Middle Ages *experimentum* was a term used to designate the magical and other recipes given in the *libri secretorum,* which Roger Bacon's *scientia experimentalis* was intended to put to test.[2423] His pro-

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2414 See [Whit62], [Gimp77], and [Sund93] p. 90 et seqq.

2415 See [Thor23], [Eamo83], [Eamo94] p. 45 et seqq., [Kiec89] p. 100 et seqq., [Hans78], and [Hans86]. Cf. also [Newm89]. See also p. 319, p. 375, and p. 438 above.

2416 [Crom59] p. 52 et seqq. Notably, Bacon was also one of the first Westerners, who knew how to make gunpowder and optical lenses.

2417 See [Baco88]. Cf. also [Eamo94] p. 45 et seqq.

2418 [Alki74]

2419 [Mass44] p. 389 footnote 1 enumerates the following "horizons" recognised in the classical Hermetic lore of sympathies or correspondences: elements, winds, hours, fluids/temperaments, faculties, virtues, rhythms, perfumes, sounds, tastes, colours, professions, clothes, flowers, gems, languages, sciences, interior and exterior organs, and classes of animals! See also [Fowd93a] p. 75 et seqq. and [Cong22].

2420 See [Thor55].

2421 It may be interesting to note that in orthodox Sunni Islam the Asharite school of philosophy, largely as a reaction against various philosophical-astrological views of the world as a self-maintained, deterministic machinery controlled by rigid causal laws, held God to be the author of each individual event and nature to be ruled by habits rather than by laws (see [Pine36], [Fran66], [Hjär79] p. 79, [Nasr92] p. 34 et seq. and [Corb93] p. 121 et seq.; cf. also [Leam96] for a discussion of al-Ghazzali's views on causality). In the Asharites' anti-deistic conception of the world, the laws of nature are delusory, only representing what *usually happens,* not what *must happen.* Thereby all events are in fact made supernatural, in starkest possible contrast to the modern Western tendency to make all events natural. The idea of "habits of nature" has recently been revived by the biologist Rupert Sheldrake, who is presently engaged in work intended to show its validity experimentally (see [Shel81] and [Shel95]) – an attempt that has predictably met with scorn and wrath from the scientific establishment. On the concept of "natural law" from the viewpoint of modern science, see [Barr90]. On the history of the concept, see also [Zils42] and [Funk86] p. 117 et seqq.

2422 This was the thesis of Thorndike's monumental magnum opus [Thor23].

2423 See [Eamo94] p. 66 and [Hack95b]. Some of the basic methods of science and engineering also bear a striking resemblance to the techniques used by some sorcerers and conjurors, such as the Hermetic-Cabalistic magi of yore or today's Indian and Tibetan magicians. According to the account of the "real magicians" of India provided in [McGi79] p. 29 et seqq. (cf. also [Davi71b] p. 310 et seqq. et passim on the Tibetan variety of such magic, [BN95] on the philosophy of theatrical conjuring, and [AW96] p. 341 et seqq., 449 et seqq.,

and 573 et seqq. on imagination and visualisation techniques in general), Indo-Tibetan magic is founded on the well-known concept of *Maya* and the belief that there is a universal subtle material principle or ether (the *akasha),* from which all we experience as matter is produced by the power of the principle of energy known as *prana*, and that there is in man another principle of "creative mind" or "creative imagination", by which he, aided by the *prana* energy principle, may project on the material principle, the *akasha,* thought-forms, which he has first visualised to himself in his mind. We are also told that this alleged human capability is just a feeble shadow of the much more powerful way God projects the forms in His divine mind onto the *akasha*. Furthermore, the adepts of "genuine East Indian magic", trained in the yogic exercises of *Pranayama,* bring about their renowned feats – such as, for example, the famous Indian rope-trick – by going through three stages: 1) a concerted and long-lasting effort of *visualisation* of the desired effect, 2) the *projection* of it (i.e. willing it into being), and 3) the *affirmation* of it by verbal or mental expressions, suggestions, or incantations, the famous *mantras*. The projection performed by the magician can either work on the mind-substance, *chitta,* of the lookers-on and, thus, "be all in the mind", the end-result of what is known as "oriental hypnotism" or "psychic influencing" ("illusionary" or "intermediate magic"), or operate directly on the *akasha,* generating the materialisation as an "astral or psychic picture" of the thought-form projected ("creative" or "high magic"); see [McGi79] p. 90 et seqq. In contrast, the "fakir magician" replaces the projection phase with subtly thought-out trickery and sleight-of-hand, in which he has trained himself assiduously in order to perfect his own mastery of the desired effects (see id. op. p. 15 et seqq.). If we provisionally accept this account, which of course is wholly at odds with modern Western "scientific materialism", but, with some provisos and doubts (in particular as to the somewhat modernistic-occultist attribution of the magic feats to a purely human rather than an at least partly superhuman, spiritual-demonic agency), seems to sort well with both a traditional Christian-Platonic worldview and the metaphysical implications of many paranormal and Fortean phenomena, we may still ask if the division-line between higher, "genuine" magic and lower, "fraudulent" magic may not be much fuzzier than McGill concedes, as trickery and fraud often seem to be used to create an atmosphere favourable to the emergence of genuine paranormal phenomena, as has often been observed in the parapsychological literature.

In any case, the scientist or engineer works much in the same manner as the practitioner of magic, in particular of the "fakir magic" variety, first meticulously visualising and thinking out designs and "experiments", which he then projects into being by trying them out through trial and error until he is confident that he has achieved the desired effects and can reproduce them through some kind of "magic demonstration" (cf. [Hack83] p. 149 et seqq.). Notably, such demonstrations or "experiments", then still all but indistinguishable from the conjurer's vaudeville, were a central component in early science (see [SS89] and [Eamo94] p. 234 et seqq. and p. 337 et seqq.). If we give up the belief in "the laws of nature", as indeed seems a reasonable thing to do if we are to take the results of parapsychology seriously, one effect will be that the division-line between phenomena created by magic and by science and engineering may become rather indistinct. If we additionally bracket the modern, quite arbitrary distinction between the *normal* and the *paranormal* for a while, we may speculate that all human activity may be "paranormal" or at least include a "paranormal" component, as may, perhaps, be most easily accepted as to skills in which some people seem to become almost supernormally proficient, such as composing music, painting, playing an instrument, performing difficult circus, acrobatic, juggling, or sporting feats, or carrying out "magic" by sleight-of-hand or trickery, but may as well be taken into consideration also for all kinds of prosaic everyday activities, such as chatting with others, reading, writing, driving a car, etc. Perhaps, scientific experiments and the feats of engineering are not as "objective" and independent of our minds as we tend to take for granted, but are somehow subtly affected through psychic influencing by the scientists' and engineers' thought-forms and wishes, as suggested by the "experimenter effect" (see footnote 1500 on p. 304) and some interpretations of the strange phenomena of quantum physics. In any case, some evidence exists that psychic factors may, at least occasionally, affect human-engineered machinery.

Firstly, it is repeatedly reported that machinery tends to stop working or works in abnormal ways in paranormal contexts – car engines and radios regularly stall at alien encounters (see, for example, [RH94] p. 168 et seqq. et passim), cell phones, clocks, cameras, and other equipment malfunction in crop circles (see [Thom02] p. 137 et seqq., [Hase01] p. 24 et seqq., and [Moul00] passim), some paranormally gifted people make computers, telephones, and other electrical appliances break down, clocks tend to stop when their owners die, messages and pictures purportedly from the spirits of the dead or other discarnate intelligences are mysteriously received via telephones, tape recorders, television and radio sets, computers, or films (see, for example, [Senk95], [SS99], [Wats92], [RB80], [Webs89], [Dani02], [GG02], [Jürg64], [Jürg69], [Thor72], [Band72], [Elli78], and [Oate96]; cf. also http://www.worlditc.org, http://www.psisci.force9.co.uk, and http://www.algonet.se/~shekinah/snit.htm), remarkable or odd photographs are taken at visionary encounters or paranormal events (see, for example, [KJJ96], [Hese00], and [Perm88]), etc. Germane to this topic will also be the puzzling semi-occult apparatuses reportedly devised by inventors such as John Keely, Thomas Edison, or Nikola Tesla, – by the way, many of the most creative inventors and scientists seem to have engaged in occult-mystical practices (see footnote 1686 on p. 353) – as well as all the kinds of 'alternative', 'holistic', or 'non-Western' medical therapies, which often appear to work quite well in spite of the fact that they largely are based on occult-esoteric theories entirely at odds with the doctrines of Western scientific school medicine (cf. [Milt96]).

Secondly, we find in documents from other times many uncannily credible accounts of events and processes, which are now considered scientifically impossible, but were then considered quite possible, such as, for instance, the alchemical transmutation of lead into gold (see e.g. [Mont81] p. 97 et seqq.) or the astrological or prophetic prediction of an event that actually happened exactly as forecast (see [Kemm25]).

Thirdly, some of the more extravagant paranormal-supernormal phenomena reported in the literature (see footnote 1532 on p. 315) naturally lead on to something like the idea of "the veil of Maya" or, perhaps better, the veil of the kind of elemental powers that St. Paul referred to by the enigmatic designation *τὰ στοιχε□α τοῦ κόσμου (ta stoicheia tou kosmou),* "the rudiments of the world", that is to say "the weak and beggarly elements" and false gods, who, *inter alia* acting, as it were, as the supervisors of the Mosaic Law, enthral man, to wit by tempting and cajoling him to trespass against the Law (see *Ep. Gal. 4, Ep. Col. 1-2,* and *Ep. Eph. 2:2).* Apparently, St. Paul held these lowly spiritual-demonic "elements", the minions of "the prince of the power of the air" and by disposition envious of and hostile to man, to constitute and control, to a certain degree at least, "this world", i.e. the fallen cosmos, and to be able to adjust its appearance so as to promote man's alienation from God through sin and disbelief and, thus, increasingly entrap him in "the course of this world" and their own power. From the Pauline-Christian point of view, the legalistic Judaizing heresies – later to be followed by Islamic legalism – implied a return to the pre-Christian thraldom to such powers. [Schl61] p. 61 astutely points out how the self-inflicted subjection also of our own times to these "elements" is divulged by the term "the atomic age". In Addition, the Pauline conception of "the rudiments of the world" is akin both to the Greek notion of "the envy of the gods", *φθόνος θεῶν (phthonos theon)* and to the understanding of the rôle of the fallen

gramme was in fact realised during the Renaissance by the new academies, such as *Accademia Segreta,* Della Porta's mysterious *Accademia dei Secreti,* and the famous *Accademia dei Lincei,* on to which Galileo was co-opted as the sixth member.[2424] From the activities of these occultist, semi-monastic and semi-secret societies, to which the furore of "the Rosicrucian Enlightenment" added colour and fervour, modern experimental science gestated, being slowly sanitised of most of its occult-mystical connotations, as the anti-occultist shift in the climate of opinion made these increasingly invidious, although many of the leading 17th century scientists, such as Kepler, Boyle, and Newton, remained deeply immersed in the traditional occult pursuits.[2425] Hence, it is certainly quite rightfully the arch-magician Faust has been made the archetypal figure of technoscientific Western modernity and the soul of the entire modern culture has been said to be Faustian to the quick, as the cachet of modernity is in fact the Faustian traverse of all boundaries, the never-ending push across "the endless frontier", the trespassing of all "taboos", and the abolition of all restraining "prejudices", spectacularly epitomised by Faust's willing, profoundly anti-Christian assent to the devil's offer of plentiful food, wealth, power, and entertainment in exchange for his soul.[2426]

In a way, science may even be characterised as a particularly degenerate form of magic, blacker than the blackest of the occult arts, which it escalates in four respects:

- Firstly, although the black magician was in the habit of perpetrating abominable crimes in order to achieve his selfish ends and, hence, often became something of a callous criminal enslaved by dark drives and forces, which he was altogether unable to command, he typically did what he did knowingly, in a wilful rebellion against the laws of Heaven, thereby

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angels, "the watchers" or □γρήγοροι, as the fallen superintendents of the physical and moral world-order in the *Book of Enoch* and other similar writings as well as in many varieties of modern occultist speculation. In fact, such notions, albeit looking odd and perplexing to many men drilled in the modern scientific worldview, will be ubiquitous in non-Western and pre-modern Western thought.

Apparently, the 'ideoplastic' (reactive, quasi-intelligent) quality used to characterise *psi* phenomena in [Hans01b] p. 216 may have a much wider applicability than just to the realm of the 'paranormal' *sensu stricto.* For example, the speculatively inclined theologian or philosopher may observe that technoscientific 'discoveries' of soi-disant 'laws of nature' and other similar 'principles' through the semi-occult experimental method – or the quasi-magic of engineering – often will be most aptly characterised not so much as 'discoveries' or 'inventions' as the outcome of a lengthy *process of negotiation* with some kinds of elusive, cunningly and deviously tempting and ensnaring "powers and principalities", which, apparently somehow operating behind the curtains of the natural world in keeping with some guiding principle not unlike the divine envy so astutely described by Herodotus (see above p. 352), most often manage to fatally entrap hubristic mankind through what seems to be just a subtly *ideoplastic* response to the foibles and vices evinced by the several technoscientific pursuits.

On the "principalities and powers" of the New Testament, see [Lang42] and, in particular, [Schl61], where it is concluded (p. 67): "These principalities exercise their being by taking possession of the world as a whole, and of individual men, the elements, political and social institutions, historical conditions and circumstances, spiritual and religious trends. Above all, their possession is exercised mainly through the "atmosphere", which is the immediate site of their power." By the "atmosphere" we are here to understand something like the (hidden) agendas that are "in the air", "the climate of opinion", through which, for example, any expressions of faith, piety, or goodness may be made to look improper, odd, or ridiculous and various cynical, wicked, or absurd – or absurdly exaggerated – ideas gain the status of obvious and self-evident "truths". Arguably, modern man, by his naïveté with regard to the influence of such spiritual powers, greatly amplified by his disbelief in them, is made an all the more easy prey to them, as also evidenced over and over again in modern history. This observation may even present us with the Ariadne's thread that leads from the witch-craze and the occult-Rosicrucian furore of the early modern era to our own times' totalitarian frenzies, anxious obsession with "political correctness", or fear- and hate-mongering neo-Darwinist discourse. This is also why St. Paul's designation "the prince of the power of the air" for the dean of "the course of the world", "the spirit that now worketh in the children of disobedience" *(Ep. Eph. 2:2),* seems so oddly apposite (see [Schl61] p. 30 et seqq.).

The evidence and ideas cited above also suit the Scholastic categorisation of phenomena into *natural, praeternatural,* and *supernatural* much better than the modern one into *natural* and *paranormal,* insofar as the praeternatural category, covering the phenomena that seemingly go against the grain of the usual order of the world as fixed by God's *potentia ordinata,* encompasses magical trickery and technical machinery, such as clocks and automata, as well as all seemingly miraculous phenomena that do not derive from God's direct intervention, but are the result of demonic activity or other non-divine paranormal agents (see footnote 1915 on p. 408). In this conception, as God "projects" the world into being from the forms in his own mind, the *Logos,* he may at any time use his *potentia absoluta* to achieve true miracles (i.e. *supernatural* phenomena), or even providentially change the *potentia ordinata,* the usual order of things, – for instance in order to send the godless "strong delusion, that they should believe a lie" *(2 Ep. Thess. 2:11),* perhaps even through the instrument of the aforementioned kinds of "powers".

2424 [Eamo94] p. 91 et seqq. provides a fascinating account of how this happened.

2425 See footnote 1553 on p. 319 above. On Renaissance magic, see also [Walk00] and [West55].

2426 On the Faust figure, see [Kret68], [Maha80], [Baro82], [Butl79c], [Nehe87], [Wutr95], and [Quis66]. On the Faustian character of modern Western culture and science, see [Spen97] p. 381 et seqq. and [Erik92]. In addition, [Bins85] provides a thought-provoking study of the Faustian, occult-alchemist roots of Western industrial society and economy. The Faustian character of computing is contemplated in [Alex97a]. Cf. also above p. 414.

also implicitly recognising these laws and his own guilt and sin as a trespasser against God and His law. Additionally, he acknowledged the dangerousness of his own doings by enclosing his arcane lore and his magic manœuvres with the most rigorous secrecy and confidentiality. In contrast, science does not acknowledge any law of Heaven or any such concepts as sin and guilt at all and, thus, has in effect removed human conscience and morality altogether from its inner workings, actually scrupling at nothing. Additionally, science embraces as a founding principle the free distribution of scientific results with no regard whatsoever paid to the possible harmful uses and consequences of these results.[2427]

- Secondly, whereas the magician knew that it was a most perilous thing to bargain with the devil and his minions, although he hoped – mostly in vain, for sure – that he would be able to outfox them and control them to his own advantage, the typical scientist, by just denying the objective existence of anything of the spiritual and moral orders, will open himself up to all kinds of surreptitious evil influences[2428], which he, refusing to even recognise their existence, will be unable to cope with and ward off. That many scientific-technological activities – from the Nazi doctors' merciless experiments on human subjects to today's "extreme science" and posthumanism – have been driven by strange or dark impulses, which seem to have something about them that can only adequately be characterised as "demonic", seems undeniable. Oddly, the pervasive scientific scoffing at religion, Christianity, and anything holy or sacred is often phenomenologically indistinguishable from – or at least closely similar to – the scoffing heard from the "entities" talking through the demon-possessed, and the frenzy, with which many scientists and other modernists preach the anti-gospels of neo-Darwinism, neuromonism, atheism, posthumanism, positivism, paraphobic skepticism, Marxism, Freudianism, etc., often seems to be imbued with the very qualities – of self-delusion, duplicitousness, pride, brutality, hatred, anger, amorality, etc. – that, regardless whether demons really exist or not, have always been associated with the "demonic".

- Thirdly, although those trafficking with and setting store by spirits and demons have always tended to fall into an abyss of delusion and falsity, they have nevertheless mostly been able to retain a clear understanding of the basic structure of the universe – that God exists, that man has a soul, which he may lose, that there are a spiritual reality and spiritual beings, as also substantiated by the praeternatural phenomena they sought to evoke –, whereas modern science is founded on a brazen and dishonest denial of these realities, consisting in i) the denial of the miraculous and paranormal in order to uphold the illusion of "the laws of nature", ii) the denial of the soul and the life of the spirit – directly available to us all, scientists and non-scientists alike, by introspection! – in order to uphold "scientific materialism", iii) the Darwinist denial of the final causes and the divine ordering of the universe in order to uphold "scientific atheism", and iv) the denial of the well-documented historical facts, on which Christianity rests, and the obvious inner goodness and truth of the Christian faith in order to uphold the anti-Christian bias of science – all of which are essential ingredients in the witch's brew modern man is force-fed, together arousing in his mind the grand hallucination of the credibility and bountifulness of modernity and the "rule of man".

- Fourthly, whereas Christianity always was the archenemy of magic, the magicians did not generally claim to be able to substitute their own lurid lore for the Christian religion, which they instead largely relied upon and embroidered and distorted in different ways for their own more or less scurrilous purposes. In contrast, modern science has installed itself as a dogmatic and intolerant pseudo-religion, which demands to have the final say on all issues

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[2427] See [Eamo94] p. 319 et seqq.

[2428] Although the belief in the existence of "the demonic" has been abolished in the modern worldview, it is both a fundamental part of the teachings of the Christian Church, theologically vouched for by its omnipresence in the gospels and the other books of the Bible, the writings of the Fathers and the great theologians of all ages, and the entire tradition of the Church, and is supported by innumerable case records – many of which in their terrible details by far exceed what can easily be explained away in terms of sheer psychopathology and the usual reductionist-rationalist psychobabble – from all over the world and all times, described in the theological, parapsychological, and anthropological literature. See, for example, [Görr89] vols. III-V, [Oest74], [Lang42], [Schl61], [Lher63], [Naum74], and [Mont76]. Two recent, concise statements of the Roman Catholic and the evangelical Protestant view of these things by leading authorities in the field are [Bald90] and [Koch_b].

of significance, whether its competence is plausibly underpinned or not, and brooks no other opinion or authority than its own. Worse, the admission ticket to many subfields of science, this self-proclaimed anti-Christian arbiter of everything, has become the denial of Christ and the fundamental tenets of the Christian religion, or even of all religions.

Although the intellectual élites, having drunk deep of the magic potion just described, from the scientific revolution onwards grew increasingly delirious about the prospects of technoscientific progress, the aversion to change and the scepticism about the beneficence of technical innovations and Faustian progressivism remained strong in the popular mind and were greatly furthered by the various waves of Romantic reaction against the onrush of the naturalistic-scientific outlook and its doubtful ethical, societal, and environmental ramifications. For instance, in the 18th century John Kay, James Hargreaves, and Samuel Crompton, the inventors of the flying shuttle, the spinning jenny, and the spinning mule, respectively, all became so unpopular with their fellow-citizens because of their inventions that they had to seek safety in flight and change their whereabouts.[2429] The Luddite riots in the 1810s, when rebellious workers broke the frames of knitting machines and other machinery and attacked factories and workshops, is probably the most well-known act of resistance to the misery and pauperism created by the Industrial Revolution and also endowed the English language with the very term, by which any critique of the current cult of technology is likely to be brushed aside, but there were many other kindred incidents, such as the outburst of destruction of threshing machines in England in 1830.[2430]

If it is true that for many technologies developed in the past the severity of the ills they would cause were not duly recognised until it was too late to prevent their adoption, typically a long time after their first appearance, this does not hold for many of the presently pursued attempts at "limit performances" in science and, in particular, within the fields of virtual reality and cyberspace that we are primarily concerned with here. On the contrary, the insight into the potentially sinister consequences of these technologies largely predates the first scientific forays into them, nay a literature depicting the most grisly antihuman dystopias, be it as a warning to mankind or as an outcry of nihilist despair, has largely provided the seminal ideas from which the VR/cyberspace agenda has been forged. So, the première for the idea of virtual reality is conventionally set to 1909, when E. M. Forster's little book *The Machine Stops* appeared in print, depicting future man as living in a dismal underground world of small cubicles, entertained and cared for by machines, desperately afraid of real life and direct contact with his fellow-men and nature.[2431] The potential of VR-like technology – "feelies" – for mind control, indoctrination, and other scurrilous purposes were first explored in Aldous Huxley's *Brave New World* and has ever since remained a popular theme in science fiction literature.[2432] More lately, the extremely glum and dystopian "cyberpunk" literature, providing the metaphor of the "consensual hallucination" of "cyberspace", has been a major source of inspiration to the virtual reality enthusiasts.[2433] There are also strong links between virtual reality and the most unkempt and extreme forms of counter- and underground

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2429 See [Mazl93] p. 68 et seqq.

2430 Ibid. See also [Sale96], who besides describing the historical events of the Luddite uprising, tries to render the ideas of the Luddites relevant to our time – a similar attempt is made in the "neo-Luddite treatise" [Rosz94]. It may also be instructive to contrast modern complaisant technoduly to the procedure by which the Amish Mennonites adopt a new technology or contraption by testing it out and critically evaluating its impact on their own way of life before they decide whether to accept or reject it, as described in [Rhei99] (cf. also [Sale96] p. 271).

Interestingly, the Amish Mennonites are the descendants of the Anabaptists, the revolutionary sect that brought about what can be characterised as the first European experiments in modernism in the 1520s and 1530s through the German peasant rebellion and, in particular, the chiliastic-communist republic they established at *Münster,* which, having implemented all the excesses of modernity, portentously ended up in orgies, anarchy, and terror. Many of the sectarians were then gathered under the leadership of Menno Simonis, who brought about the transformation of the revolutionary sect into an orderly congregation, making it a conservative stronghold that has ever since been able to resist the temptations of modernity for the preservation of its own old-fashioned, bucolic ways of life. See [Wils70] p. 128 et seqq. for a brief account of the history of the Mennonites and [Davi92b] p. 65 et seqq. for a discussion of some of the radical ideas they toyed with in the 16th century. On the radical Reformation in general, see [Will00], and [Dülm77]. Cf. also [Cohn70a] p. 252 et seqq., who regards the Anabaptists as part of a long tradition of antinomian anarcho-revolutionary millenarianism, which he traces back to the "amoral supermen" of the medieval heresies of the Amalricians and the Free Spirit and makes the precursor of Bakunin, Nietzsche, and the 19th and 20th century bohemian radicals, mystics, occultists, and libertines described in [Godw94], [Webb76], [Webb90], and [Gree86].

2431 [Fors1909]. Cf. also p. 270 above.

2432 [Huxl55]

2433 These terms were coined in [Gibs84], William Gibson's famous novel *Neuromancer*.

culture. The notion of virtual reality as a kind of "electronic LSD"[2434] has been brought into relief by the prominence in the VR arena of drug prophets and drug enthusiasts, such as Timothy Leary, Douglas Rushkoff, and Mark Pesce, and publications such as the *Mondo 2000* magazine.[2435] Much of the publicity, literature, and discourse surrounding the VR area is permeated by an atmosphere of contrarian, deviant gnosticism and extreme radicalism and nihilism, where technopagans, cybershamans, cyberfeminists, techgnostics, postmodernists, extropians, radical theorists, grimacing cyberartists, and others of the same ilk descant on various favourite topics of theirs in an awkward, jargon-laden, often ostentatiously decadent and sensationalist style, for which Voegelin's categories of "disorientation" and "pneumopathology" seem to provide a peculiarly accurate characterisation.

The ethical chaos typical of the value subjectivism of the "postmodern condition" no less than that of modernism, is well illustrated and epitomised by an – *per se* both perceptive and thought-provoking – essay entitled *Final Amputation: Pathogenic Ontology in Cyberspace* written by the Crowleyite technopagan Mark Pesce, the designer of *VRML* and a fervent evangelist of the vision of a VR-based cyberspace.[2436] Having been awakened to the dangers of VR technology through the film *Lawnmower Man,* Pesce, on the basis of McLuhan's idea that every technology amplifies one sense at the cost of another[2437], characterises the paradise of shadows he himself strives to bring into being as "the final amputation" and considers the dire implications of this final amputation in terms of both unintended undesirable consequences and deliberate malevolent abuses.[2438] Whereas the examples of the former type range from the induction of nausea and motion sickness to a possible general fluidisation or even dissolution of the self amongst long-time sojourners in "holosthetic environments"[2439], the possible malicious uses include, for instance, indoctrination, brainwashing, torture, games and other forms of entertainment of an ethically doubtful content, and suchlike.[2440] Endowed with a certain knack for neologisms, Pesce analyses these phenomena through categories such as "electronically-mediated schizophrenia" (the split of the self from the body by telepresence), "holosthetic psychosis" (pathological psychical states induced by virtual reality), and "telepathology" (the transmission of pathologic "ontologies" over a distance). These chilling hazards notwithstanding, he cannot bring himself to disavow his own pet toy and, thus, ends up debonairly concluding that these possible terrors "do not outweigh the potentials for creative play and communication" and makes a plea for both law-enforced regulations based on a charting of the possible abuses and for the development of "vivogenic holosthesia", such as "trans-spaces" for (neo-pagan) religious rites. To anyone who does not share in Pesce's insouciant fascination with the virtual and his predilection for technopaganism, the proposed remedies will probably appear feeble and naïve.

In our view, the troubling questions as to the dangers, gnostic subtext, and doubtful ethicality of virtual reality can by no means be so light-heartedly dismissed. From history we can at least learn one thing, to wit that all appalling abuses of a technology that can be conceived of *in intellectu* will also, sooner rather than later,

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[2434] See [Rhei91] p. 353 et seqq., [Zett96] p. 91 et seqq., [Broo97b], and [Keow98].

[2435] See, for example, [RSM92], [Lear94], [Rush95], [Rush99], and http://www.mondo2000.com. On Pesce, see above p. 489. On the intimate connections between the computer industry of California and the psychedelic drug 'culture' of this region, see also [Kirn91], [Hill99] p. 28 et seq., and [Davi98] p. 147 et seqq. et passim.

[2436] [Pesc94]

[2437] See p. 485 above.

[2438] The literature on the possible dangers of virtual reality is astonishingly thin. In fact, apart from a few papers and articles, such as Pesce's, it seems to be limited to various asides and short snippets of more or less angst-ridden reflection in the technical or popular VR literature (see, for example, [Rhei91] p. 387 et seqq., [Krue91] p. 263 et seq., [AB92b] p. 259 et seqq., [LB95] p. 211 et seqq., [Zett96] p. 91 et seqq., and [Grah00b] p. 151 et seqq.). In a chapter of *Virtual Realism* (see [Heim98] p. 33 et seqq.), Michael Heim discusses the "cyberspace backlash" and mentions a rather large number of cybercritical books, of which, however, only few deal with virtual reality at all and then only briefly and perfunctorily. The same holds for the titles listed in the commented bibliography in [Groo99] p. 189 et seqq. [SJ93] is a popularly written book-length study of the likely future ramifications of VR technology, but despite its promising title *Glimpses of Heaven, Visions of Hell* this work does not delve deep into the darker potentials of the technology. Much the same is true for [Schr96b], a study of "the social dynamic of virtual reality technology". More rewarding are the collections of articles in [Broo97a] and [Wedd96], both significantly being issued by religious communities with an open mind about the "demonic" aspects of modern technology, whereas the anthologies of postmodern and radical criticism [Mark96a], [BB95a], [BD94], and [Wood98] have but little meat to offer on these issues, except for the short paper [Keow98], tellingly authored by the editor of *The Journal of Buddhist Ethics*. Nor did I find the the irate and rather tiresome radical tirades in [KW01] very helpful. Cf. also and [Ster93], [Ågre98a-b], [Hill99], and [Lang00]. A few additional references will be given in the footnotes below.

[2439] Cf. [WM97] and [Heim98] p. 173 et seqq.

[2440] Cf. [Rhei91] p. 387 et seqq., [Krue91] p. 263 et seq. and [Ster93].

be applied also *in re*. No sooner were there aeroplanes than man had to look towards the heaven in terror of bombers and kamikaze pilots. The automobile inevitably implies accidents, pollution, the roaring din of the motorway, the abomination of an asphalt-lacerated landscape, the rootlessness of modern man.[2441] If virtual reality can be used for propaganda, indoctrination, brainwashing, torture, the induction of "holosthetic psychosis", and the propagation of all kinds of "telepathology", we can rest assured that it will. Neo-pagan mumbo-jumbo or phrases about "vivogenic ontologies" will obviously be of little help here.

With this larger picture in mind, let us now return to the agenda of *realistic computing* outlined in the earlier parts of this dissertation in order to attempt to arrive at some kind of verdict on it from an ethical point of view. What will concern us here is mainly one of the pillars, on which it rests, to wit the virtual reality/cyberspace one. In our discussion of the matrix of the main Western strains of thought and ways of being-with technology above, we provisionally dismissed 1) *modernism* as being incapable of providing any well-founded guidance in ethical matters because of its coupling to *value subjectivism* and 2) *Enlightenment optimism* as being devoid of credibility due to the widespread disillusionment its application for 200 years or so has brought about. We also criticised *mystical syncretism* for weakening or undermining the objectivity of ethics and tried to show its Gnostic-occult strain to be the *fons et origo* of the derailment that shows in present-day *modernism* and *Enlightenment optimism.* To the present writer, the outlook that offers the only trustworthy promise of ethical guidance will thus be *traditional theism.* As we rejected its *Enlightenment optimistic* variety as a vicious form of idolatry, which, *pace* Lynn White, is basically at odds with fundamental theistic, Jewish-Christian values and attitudes, being brought up only late in the history of Christianity by philosophers steeped in Hermetic occultism, Neoplatonism, and Joachitic millenarianism, such as notably Roger Bacon in the 13th and Francis Bacon in 17th century, and never gaining widespread theological acceptance outside some rather devious varieties of Protestantism, there remains in our eyes only two options worthy of consideration, viz. the combination of *traditional theism* with either *Ancient skepticism* or *Romantic uneasiness,* which, as we argued earlier, perhaps rather should be referred to as *Pragmatic uneasiness,* inasmuch as theists tend to be more pragmatic than Romantic about technoscience.

In brief, a theistic-Christian ethics will have three modes of operation: i) affirmation of the good given by God, ii) rejection of what is abhorrent to fundamental Christian values and man's conscience, which both are grounded in the divine *Logos,* and iii) a willingness to attempt to rectify, sanctify, and help towards the good the actually existing, insofar as there still seems to be some hook for grace in it.[2442] Let us now try to bring this attitude to bear on virtual reality and the agenda of realistic computing.

From a theistic point of view, the really interesting question as to the acceptability of virtual reality will be the one about "the spiritual effect of immersion in cyberculture", well formulated by the Orthodox cleric Vincent Rossi:[2443]

> *How does spending more and more time in virtual reality affect the life of the soul–the substance and quality of one's thoughts, feelings, desires, emotions, ability to pray, concentrate and center oneself, ability to experience compassion for others, to acquire the virtues, love of neighbor, concern for creation and love of God, and so on?*

If, as Rossi advises us, it is "very unwise not to fear the dehumanised abstractions into which a lucipheric, gnostic, cybercultural cognitive universe will draw us"[2444] and, as Mark Slouka maintains, cyberspace in fact

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2441 Cf. [TO95] p. 130 et seqq.

2442 It should also be noted that in a religion such as Christianity, where, in contradistinction to what is the case in Jewish and Moslem casuistry, ethics is based on personal conscience, there is an essential difference between individual and collective ethics. For one thing, the ethical judgement, which the individual arrives at for his own part by searching his own heart, is not automatically to be extended to the collective. For instance, if a Christian arrives at the conclusion that his conscience forbids him to eat pork, drink wine, or participate in warfare, he should not objurgate his Christian brethren for not paying heed to these observances of his own liking, nor are they supposed to find fault with him for these idiosyncrasies of his, at least as long as they remain within the bounds of decency and reasonability.

2443 [Ross98b]

2444 Ibid.

constitutes a fourfold assault on the most fundamental building-blocks of human existence, viz. identity, place, community, and reality[2445], there is obviously reason for concern. Man is an extremely malleable and impressionable species of being, who is deeply affected and shaped by what he encounters and experiences, but even more by what he comes to worship. Above, we argued that the unbounded technoscientific idolatry, which comes to the fore in the projects of "extreme science", such as virtual reality, is grounded in a kind of spiritual quest, albeit not an authentic, wholesome variety, but the deformed, immanentist degeneration phenomenon Voegelin called "pneumopathologic", which, far from offering the promise of spiritual rebirth and a preparation for divine grace, presents mankind with the menace of a gradually escalated separation from the wellsprings of being, a theophobic flight from God into a gnostic shadow world.[2446] What is needed is not a deepened immersion in a debilitating artificial media world where all kinds of dubious or unsavoury messages are bandied about, touted and peddled by the various self-appointed conditioners of mankind, nor doubtful experiments in life-like, but anonymous interaction between faceless, disguised cyber-ghouls, liberated from all the shackles of responsibility, morality, and decency imposed by real-life communities and real-life situations. On the contrary, what today's bewildered and jaded mankind really needs is not more of vacuous "experiences", but more edifying "face to face" contact with real human beings, more engagement with the authentic reality created by God, and, in particular, more time for peace, scriptural study, prayer, contemplation, worship, and the stillness, where man can probe for the innermost meaning of being and, by opening his heart to divine grace, approach and meet God.

Cross-fertilised by the kind of moral nihilism, *Übermensch* ideas, and cult of 'experience' typical of modernity and postmodernity, tomorrow's VR entertainment will of course offer all the brutality, decadence, obscenity, and vulgarity of today's video games, telecasts, and video films, but writ large, being, potentially at least, capable of producing so much more of obtrusiveness and realism than ever will be possible on a small CRT screen. By offering a highly lifelike, but imaginary "room of one's own", where no normal moral responsibilities and restrictions longer obtain and where "telepathological" influences from all the Malebolges, Sodoms, and Gomorrahs of the world will be directly accessible at everyone's fingertips, cyberspace will present insuperable evil temptations to many people, not a few of whom will be children or adolescents, who, freed from all supervision, may try out virtually what it is like to *be* a soldier with a machine-gun killing one's neighbours, a torturer at work, or Count Dracula, Jack the ripper, and Marquis de Sade ministering to their own respective caprices and fancies. No longer will we hear complaints about "the disappearance of childhood"[2447], but now the laments will be about the intrusion of the deepest recesses of Hell into everyone's sitting room and nurseries.[2448] Nor can we hope that man will be able to cope with such an assault on his own essence in any reasonable way. If it is true that today's electronic media, such as television and video games in particular, are highly addictive, what are we to expect from a virtual reality already dubbed "electronic LSD"? If today's electronic media have been highly conducive to the escalation of violence in society and the dissolution of family and community life, what can we expect from those growing up with a daily dose of hyperrealistic virtual carnage and carnality? If electronic media have already brought about the appearance of what McLuhan called "discarnate man", what will the man be like who will appear from long-time immersion in all kinds of profoundly corrupt and perverted virtual realities?

Juxtaposed to such apprehensions and perils, the perceived advantages of virtual reality and, together with them, the agenda of realistic computing dwindle into puny and ludicrous insignificance. The quest for virtual reality and cyberspace together with other kindred outpourings of *extreme science,* being the culmination of the Faustian, technomaniac conflagration kindled by the medieval and Renaissance adepts of the occult sciences, was at its roots but a brazen attempt to regain Paradise by storm, albeit not the true thing, the serene heavenly abode, of which St. Paul caught a glimpse when he was enraptured to the third heaven, and for which man has

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2445 [Slou95]

2446 The theophobic aspect of media technology is discussed in [Alex97b], who also reminds us of how the first impulse of our first parents after the perpetration of the original sin was to hide away from God "amongst the trees of the garden" *(Gen. 3:8).*

2447 [Post94]

2448 See [Broo97b] for some perceptive remarks about what is to be expected. He concludes by asking (p. 126), "Will virtual reality be any more virtuous as entertainment than its predecessors in the movie, television, cable TV, and interactive CD-ROM industries? Will it raise us to new heights of moral purity and virtue, restoring our lost national innocence? Only someone very naive and dull, I think, would answer yes at this point in history. Virtual entertainment will continue to steer us–apart from an act of God–toward the spiritual landscape that existed before the last great judgment when imaginations before the great deluge dwelt only on evil day in and day out." Cf. also [Zett96] p. 92.

arduously to prepare himself through the unpopular way of the cross, but the magician's earthly, immanentist, undemanding parody of it, open to all for free, the synthetic pseudo-Paradise replacing nature with artificial reality, abstract shadows, and hedonistic pipe-dreams, which paradoxically fuse the magician's craving for absolute domination over being with the gnostic's craving for total liberation – from the flesh, from the world, from the order of societal life, from all pressing shackles of morality, piety, and loving-kindness.

Extreme science, itself the uttermost expression of extreme pride, is presently bringing about the extreme transformation of nature into an all-encompassing artificiality, the extreme loss of innocence, extreme anomie, extreme moral dilemmas, extreme anxiety, extreme terror, extreme godlessness, extreme wickedness, extreme sin, inundating the world with the dubious products of its restless activities, the whole gamut of fine technoscientific blessings – the bombs, mines, and cannons that constitute the very starting-point and fundament of modernity; the strange, sickly animals "improved" by breeding or genetic manipulation so as to fit the Gulags of "meat production", where they are fed on the cadavers of their own fellow-animals not "fit for survival"; the novelty of cannibalistic medicines prepared from human embryos – obviously, no longer is it enough for the modern "enlightened altruist", the man who has committed himself to the "Umwertung aller Werte", to use the earthly remains of the unwanted fellow-human as soap or as a tray into which to knock the ash of his cigarette[2449], but now he craves for a paedophagic feast upon the poor carcass so as to let himself regain the sap the murdered foetus was deprived; the pan-artificialisation of the environment through rapidly-growing conurbations, eyesore architecture and landscaping, "industrial design", "graphical user interfaces", "ubiquitous computing", "virtual reality", and nanotechnologically manipulated matter and life; and, below the surface of this garden of technical delights, the radioactive deposits waiting for the armed attack, the unexpected geological event, or the tiny mistake of human calculation so they can start leaking death and destruction. Tellingly, the otherworldly being, whom modern man will be most likely to encounter, will no longer be the angel or demon of yore, nor the fairy or the leprechaun, but their alien cousin, the look-alike of the aborted foetus, who, having abducted man into a nightmarish, technodemonic virtual spacecraft reality, performs on him bizarre scientific experiments, which apparently somehow pertain to the realm of genetics and reproduction – thereby, it seems, bringing into stark relief fallen man's all sinful trespasses against God, the creation, and his own fellow-beings.[2450] Gone is the time when the scientist was celebrated as the heroic saviour of mankind or even when it was thought proper for him, in his self-complacent and self-pitying pride, to exculpate himself by quoting the Bhagavad-Gita verse, "now I am become death, the destroyer of worlds", as Robert Oppenheimer saw fit when contemplating the blast of the first Trinity test bomb, his own brain-child, in Jornado del Muerto in 1945, but now the Biblical verse will turn on him, "it was better for him that a millstone were hanged about his neck, and he were cast into the sea". Before us we can now dimly apperceive a rapidly rising tide of evils and terrors beyond all compare, destined to eclipse all the previous evils and terrors of the sordid history of mankind, as man in pursuit of the innerworldly Pleroma encounters – instead of the Paradise on Earth – his own implementation of Hell, the Apocalypse, and Armageddon.[2451]

Try as he may, in the end no man, scientist or not, can escape the sword, which "shall pierce through thy own soul also", but has to make up his mind about which Paradise to pursue, the one of serene bliss in Heaven, or the one of garish cacophony on Earth. When tempted by the devil's cajolery – "command this stone that it may be bread", "if thou therefore wilt worship me, all shall be thine", and "cast thyself down from hence" [2452] –, he may take his cue from the great chain of acolytes of Old Nick – from the ancient Gnostics to the current super-hip Californian techgnostics, from the proto-scientist Dr. Faust to today's technolaters and neo-scientistic energumens of extreme super-science, frantically dancing around their golden calves. But, of course, he can also, by the grace of God, choose to make every effort to save his own soul and to follow in the footsteps of the One, who answered the devil thus pertinaciously, "Get thee behind me Satan: for it is written, Thou shalt worship the Lord thy God, and him only shalt thou serve."

[2449] Cf. [Harr96] p. 199.

[2450] See [Cass94]. [CLK00] p. 255 et seq. cites estimates, which suggest that millions of Americans may have had alien abduction experiences.

[2451] Need I once again remind the reader about Taubes' terrible hunch that the mainspring between all this modern madness is a compulsive eschatological urge for the end of the world, the Apocalyptic event that will finally reveal the meaning of human existence? See [Taub91] and p. 474 above.

[2452] *Ev. Luc. 4*

3.5 CODA

Mind not high things, but condescend to men of low estate. Be not wise in your own conceits.

Ep. Rom. 12:16

For the wisdom of this world is foolishness with God. For it is written, He taketh the wise in their own craftiness. And again, The Lord knoweth the thoughts of the wise, that they are vain.

1 Ep. Cor. 3:19-20

If I avowedly have in this long chapter attempted something few would consider judicious and advisable, venturing to appraise and join together concepts, ideas, and scraps of data and history garnered from a great number of disciplines and realms of scholarship, in which I certainly am no expert and for which I in some cases even lack the most fundamental qualifications,[2453] if I, at that, have herein repeatedly begged to differ from the ruling opinions amongst those in the know, occasionally even doing so from arguments of a metaphysical, theological, or even – on the surface of it at least – "mystical-occultist" character, odious to most present-day Academics, if I have ever and again sided with minority parties and widely loathed or apparently lost causes, which some would not even dare to mention *sub rosa,* let alone give serious consideration to in print, and, if I, finally, have brazenly taken up the cudgels against that greatest idol of our times, to wit the golden calf of science, I should nevertheless like to end this seemingly iconoclastic, albeit in its intentions rather recuperative, endeavour on a note of humbleness.

Firstly, this chapter is by necessity largely a work of "armchair scholarship", where I have drawn on the diligent and often excellent explorations of others, but have certainly not done the kind of primary research – in manuscripts, in archives, in the lab, in the field – many would consider the ticket of admission to their special area of interest. Although I have great respect for this kind of research when it is competently done, the goal of the present study has not been to provide such a specialised enquiry – certainly something altogether unconscionable in a thesis in computer science –, but to come to terms with and assess the point, meaning, validity, and ethicality of technoscience and its claims, methods, and worldview in order to be able to come to terms with and assess the point, meaning, validity, and ethicality of both computing in general and the previously suggested agenda of "realistic computing" in particular, which both, I contend, can only be correctly interpreted and evaluated in this greater context.

Secondly, although I have made every effort to obtain correct and up-to-date information about the different areas I have touched upon, it may seem to be a deed of most foolhardy derring-do to try to cover so many areas, of which my own knowledge by necessity is limited. Indeed, it will be unavoidable that I, lacking the expert's command of the literature and first-hand knowledge of the current issues and trends in his area and, additionally, being something of a slow reader myself, have perpetrated various howlers, which, most probably, will seem unpardonable to the insider. All I can say in my own defence is that I am well aware of my own shortcomings in these respects and that I greatly welcome criticisms and corrections from the experts and insiders. In particular, I, who am not a theologian by training and profession myself, but, at best, a lay theologian and avid seeker after truth, would gratefully salute and very much appreciate scrutiny and critique of the ideas and views I have presented and advocated by Christian theologians and the Church.

Thirdly, in an investigation of this scope there will by necessity be much that has been treated much more superficially than I would have liked it to be. Indeed, this study should be read more like a tentative road map for further exploration than as a dogmatic statement of clear-cut "results". On the other hand, by trying to transcend the artificial boundaries between disciplines and fields of research in order to overcome the curse of specialism, I hope I have been able to achieve two important objectives, albeit by necessity very imperfectly: To begin with, I have tried to adumbrate how far widely different disciplines of both science and scholarship are in fact subtly guided by extrinsic, deeply irrelevant and misleading assumptions about reality – by con-

[2453] For example, it will seem rather impertinent to descant on the history and meaning of Judaism and Islam without any knowledge of the Hebrew and Arabic languages.

siderations about "political correctness" and the political demands of Tage Lindbom's "rule of man", by research trends and vogues of questionable value, by what is falsely believed to be the "greater picture" emerging from today's science and scholarship, and, above all, by metaphysical presuppositions, which, albeit constituting the foundation of today's science and the entire modern worldview, are, as I have repeatedly argued, demonstrably erroneous, being based on a denial of large portions of reality, of the "paranormal" and "anomalous" as well as of our own fundamental experience of "being here", of being conscious, ethically responsible beings in quest for God and the truth about being. Additionally, I believe I have shown that there are alternative and much more reasonable and profound ways to look at the world, man, and history than the ones provided by the shoddy, superficial, and grandiosely delusive worldview of – scientific or other – materialism and atheism, nay that, as already Socrates and Plato, who in fact was the founder of the true Academe, of which the current bulwark of dogmatic anti-Christian and anti-religious stupor is but a debased travesty, found out, a truly *open* quest for the truth will by necessity save us from the materialist and atheist stupor and lead us, through the life of the spirit, towards the Ground of Being, towards the Logos, "Who is the image of the invisible God, the firstborn of every creature: For by him were all things created, that are in heaven, and that are in earth, visible and invisible, whether they be thrones, or dominions, or principalities, or powers: all things were created by him, and for him: And he is before all things, and by him all things consist."[2454] Nonetheless, I am more than willing to concede in my work the omnipresence of loose ends, the incompleteness of much of the evidence cited, the sketchiness of many of the relations and interpretations given, and the need for further and more detailed exploration of many of the topics covered.

Fourthly, the often strong wording, controversialist tone, and rather openly Christian formulations I have made use of in this chapter will certainly give umbrage to many, who have made the current style of bald, soporific scientific writing, sterilised from anything that smacks of religion, metaphysics, or personal opinion, into an eternal scientific by-law that must never be violated. Although I have very consciously declared war against this canon, which I consider groundless, deceptive, debilitating, and dangerous, as it in effect cements the Cartesian divide, making religion, metaphysics, and ethics appear subjective, irrelevant, and unrelated to the world of "hard scientific facts", and, thus, *de facto* serves as a disguise for the deeply anti-religious and anti-Christian metaphysical bias of modern science, my intention has not been to offend or scoff at scientists or scholars, neither collectively nor as individuals, but rather to, if possible, awaken the reader to the dubiousness and perilousness, nay unscrupulousness and monstrosity of much that passes as "science", to the groundlessness of the ubiquitous modern credulity towards anything that comes in its garb, and to the way all this scientific evolution-babble, gene- and meme-babble, neuro-babble, psycho-babble, and all other kindred babbles insidiously penetrate, bias, and pervert our language and rob it of both its dignity and indispensable spiritual-ethical dimensions.[2455] If I have gone too far in my onslaught on these and other holy cows, I will be more than happy to apologise for this.

Fifthly, it may seem odd, not to say rather self-defeating that I, after first having asserted my own deep scepticism as to man's capability to understand history and descry in it any grandiose patterns[2456], immediately indulge in a lengthy attempt to do just what I have just railed at. But what I have tried to do in the historical section of this study is not futilely to formulate yet another historiosophical system, but just to point at the obvious fact that history is essentially Christocentric – and most spectacularly so from the onset of the Christian era – and that our own epoch, albeit being imbued by the most relentless anti-Christianism, of which technoscience certainly is a keystone element, *eo ipso* remains as Christocentric as ever – thereby, besides, providing the eschatologically inclined of us with fodder for much lucubration and speculation over the possible present-day fulfilment of the Biblical prophesies concerning widespread end-time apostasy from the Christian faith. In any case, the seminal idea of my historical exposé was provided by my own contemplation of the oddly neglected antithesis between Christ and Faust, or more specifically between the temptation of Christ, who by rejecting the devil's offer for food, power, wealth, and strange amusements set the example every Christian should strive to imitate, and the diabolic pact of the magician Faust, who by selling his soul to the devil in order to procure these very selfsame commodities became the archetypal figure of our own modern, technoscientific, atheistic-materialistic era, "the rule of man".

[2454] *Ep. Col. 1:15-17*

[2455] Cf. *Th. III.82.4.*

[2456] See footnote 1662 on p. 344.

One lesson of the Faust story is of course that the Fausts always lose in the end, as the devil finally arrives to demand his pay. Thus, the magician's and the scientist's quest for knowledge of "high things" will be futile, as man cannot by himself, not even when abetted by the devil, who, as "the Father of Lies", is really an unusually untrustworthy source of advice and information, reach an adequate and all-encompassing understanding of the world, which rather is the prerogative of God, but if man becomes so proud and arrogant as to believe such he will only entrap himself in some kind of secondary pseudo-reality, as so well outlined by Voegelin in his masterly analysis of the gnostic intellectual's progress from self-deception, via intellectual swindle, to demonic mendacity.[2457] It also seems a most proper manifestation of divine justice and wisdom that good "men of low estate", who lead a simple, pious life without hankering after "high things", should in the end have the advantage over the arrogant philosophers and academics, who, fatuously puffing themselves up with such delusive knowledge and vacuously claiming to understand and control the world through their own constructed pseudo-realities, which as Charles Williams taught us can as well be construed as varieties of "hell", believe themselves fit to rule the world, when they in fact only work towards its and their own havoc. Thus, my own humble ruminations and explorations in the present study are by no means to be considered as an attempt to ferret out the hidden pattern of history or anything of that order, but rather as tentative gropings in the dark, motivated by my own need to reach an ethical verdict on the agenda of "realistic computing", a need that also has compelled me to try to evaluate the many grand, but doubtful claims and assumptions made by various "master thinkers" as well as by that great faceless collective of such "master thinkers" called science. That such an attempt by necessity will be destructive in nature rather than constructive is obvious, "for the wisdom of this world is foolishness with God" and the "foolishness of God is wiser than men; and the weakness of God is stronger than men".[2458]

[2457] See above p. 341.

[2458] *1 Ep. Cor. 1:25*

Whereas the first chapter of the present study provides an introduction to the fundamental principles behind today's commercial distributed object and component technologies and the core parts of the four major component infrastructures, *COM/ActiveX, .NET, CORBA,* and *JavaBeans/Enterprise JavaBeans,* this appendix will deal with the subject matter of "networked components" at a little greater length, but with a focus on *Microsoft's* technologies only – a motivation for this choice will be given below. The bulk of the current section was written in 1998-99, and it has unfortunately not been possible to bring it up to date with *Microsoft's* current *.NET* strategy and the various other developments on the bustling and busy *Internet* arena the last few years.[2459] Since the purpose of this appendix is not to give an up-to-date description of *Microsoft's Internet* strategy, but to serve as a background for the discussion of implementation choices of the agenda of "realistic computing", this flaw will, I contend, be of limited significance.

Internet client/server architectures is doubtless the topic de jour, although only few technologies will qualify as such – in fact, one may argue that there are only two worthy thoroughbred and reasonably complete candidates around, *Sun's Java* platform and *Microsoft's DNA (Distributed interNet Application Architecture).* Whereas the vision of the Java platform is epitomised by the shibboleths of object-orientation, network-centricity, and *Write Once, Run Anywhere (WORA)* portability, the corresponding cornerstones of *DNA* will be component-orientation, the personal computer as an oriel window onto the web, and the vision of *Windows* everywhere. In point of fact, *DNA* is an audacious attempt to make personal, web, and enterprise client/server computing coalesce into a new unified style of computing based on the *COM (Component Object Model)* programming model and the *Windows* operating system family. *DNA* is also distinguished by its overriding goal of perpetually elevating application development to higher and higher levels of productivity and of dislodging all the drudgery and low level aspects from programming through the utilisation of components, automation, and visual tools. Below, the *DNA* edifice will be subjected to a rather detailed scrutiny, supplemented by occasional side-glances on the Java platform and other relevant *Internet* and enterprise client/server technologies.

This chapter, cast as a case study of *Microsoft's DNA (Distributed interNet Application Architecture),* will try to throw some light on the current state of the art of *client/server* computing as per early 1999. *DNA,* arguably to that date the most daring attempt to create an all-embracing architecture for distributed computing, was a child of the late 1990s and, as such, endeavoured to synthesise two of the most potent and compelling ideas and phenomena of the computer age in general and the 90s in particular, to wit the *personal computer* and the *Internet.* Although both these notions hark back to the programmes of "augmentation" of man's capabilities and "man-computer symbiosis" formulated by Engelbart, Licklider, and others in the 60s and the idea of the computer as a communicative interface to the rest of the world was framed very early[2460], the personal computer, when it finally made its commercial appearance, was essentially an insular, introvert, and truly *personal* device that only over the years grew communicative, extravert, and gregarious. Admittedly, personal computers were soon enough connected with each other through *LANs (Local Area Networks),* which, in due time, coalesced into enterprise-wide *WANs (Wide Area Networks).* However, not until recently have these departmental or company-wide archipelagos of computer machinery more generally started to agglutinate into the global communication congeries known as the *Internet,* although indeed this interconnection channel itself also draws its lineage back to the late 60s and all since has been winding its arachnoid way through the decades, steadfastly and diligently interlacing and interweaving the computing community into an increasingly elaborate *world-wide web.*

Personal computers and networking begot *client/server* computing, which soon came to be regarded as a modern, cost-efficient, and user-friendly alternative to traditional mainframe computing, causing innumerable companies to enter the "new era" heralded by the advocates of *downsizing* and *client/server* development. The need for infrastructures and unified system architectures for such *client/server* endeavours spawned a plethora of wide-ranging technical efforts, such as *IBM's SAA (Systems Application Architecture), DCE (Distributed*

[2459] Notably, *Microsoft* no longer makes use of the terms *DNA (Distributed interNet Application Architecture)* – or *DNA 2000,* which was the preferred designation for a while in 1999-2000 – to describe its overriding network strategy. Nevertheless the larger part of the account given below, albeit in need of update and containing some rather glaring anachronisms, will still be accurate.

[2460] See e.g. [Enge62], [EE68], [Lick60], [Lick65], [Lick68], [Kay69], and [Kay93].

Computing Environment) from *OSF (Open Software Foundation), OMA (Object Management Architecture)* and *CORBA (Common Object Request Broker Architecture)* from *OMG (Object Management Group),* and, more recently, *Sun's Java for the Enterprise* and *Microsoft's DNA.*[2461] The circumstance that the personal computer currently is about to take on the rôle as the interface to a world-wide rather than just an enterprise- or department-wide network implies that the substructure needed for *client/server* development will have to provide both an *enterprise architecture* and an *Internet architecture.*[2462] Presumably, the difference between these two varieties will gradually fade. In fact, *DNA* may be understood as a radical attempt to amalgamate both kinds of architecture into a unified whole.

Why single out just *DNA* for this study and not, say, the currently immensely popular *Java* platform or the *CORBA* technology, so highly eulogised by its own following of steadfast and loyal liegemen? The background for this is a decision on infrastructure I recently had to make for my own research project, the *Panopeus* project. Having spent considerable time in a brown study, I eventually came down in favour of *DNA,* and the rationale for this choice, which in the end was a very easy one, may be summarised in four down-to-earth arguments:

- *Single-vendor implementation.* In contrast to *CORBA* and *Java for the Enterprise, DNA* is made up from technology that actually exists *now,* nay, is defined by *one* single-vendor *implementation* rather than by *specifications* to be implemented by any and all. Software claiming support for *CORBA* or for *Java for the Enterprise* regularly provides for only a subset of these specifications and tends to lean heavily on proprietary extensions at that. For a *CORBA*- or *Java*-based client/server system to be built, software will have to be composed from a plethora of vendors, which is an approach liable to all kinds of interoperability and compatibility problems. In addition, many of these vendors and products will be quite ephemeral, due to the smallness and immaturity of their markets.
- *Completeness. DNA* covers almost all aspects of a client/server system. Whereas this will be true for the *Java* platform as well, at least if one accepts its least-common-denominator approach to *GUI* design, it is not at all true for *CORBA,* whose *services* and *facilities* are still only spottily implemented and whose *GUI*-oriented *OpenDoc* component infrastructure was marooned by its own champions in early 1997. Consequently, *CORBA* has increasingly tended to become a server-oriented niche technology for *UNIX* or cross-platform object-to-object communication.
- *Component-orientation.* In contrast to *Java* and *CORBA, DNA* is a component-based architecture. Both *Java* and *CORBA* are basically *object-oriented,* not *component-oriented*, and the bedrock of the *Java* platform is object-oriented frameworks. In our view, components hold much more promise as an architectural foundation than object-oriented frameworks, which tend to be difficult and time-consuming to master and use proficiently and will be wont to engender bloated and twisted programme code, difficult both to comprehend and maintain.[2463]

[2461] There is a rich literature on client/server architectures. [Bers96] is a solid textbook on most aspects of "traditional" client/server technology. [Ligo97] and [OHE96a] also provide comprehensive treatments of the subject. [Edwa97a] presents a number of case studies of 3-tier client/server systems, and in [Vask95] David Vaskevitch, vice president of *Microsoft's* distributed applications platform division, surveys the client/server area from a "strategic" viewpoint. Unfortunately, the staggering progress of the state of the art in client/server technology makes many books seem dated already when they appear in print.

[2462] *Enterprise* and *Internet architectures* should not be confused with *software architectures.* Rather, they provide infrastructures that may be taken advantage of when building a system that adheres to a certain software architecture, such as (three-tier) client/server, but are not per se software architectures. [BCK98] and [SG96] are two important works on the currently very vigorous discipline of software architecture.

[2463] Although this may avowedly appear as a simplification, there will currently be two major competing interpretations of why object-orientation has not made good the high-pitched expectations attached to it since the middle of the 80s. According to the one, various deficiencies in *C++,* the by far most used object-oriented language, such as inadequate memory protection, lack of automatic garbage collection, etc. are to bear the brunt of the blame. According to the other, object-orientation is per se problematic, and, in particular, its use of implementation inheritance and large frameworks tends to breed complexity, fragility, lack of encapsulation, and unproductive pre-occupation with low-level programming issues. Whereas the component-orientation of the *COM/ActiveX*-based *DNA* sorts well with the latter understanding, the starting point of *Java* is the former view, and although support for *JavaBeans* components has been added to *Java,* these appear more as an afterthought than a central concept of the *Java* platform, which still rests firmly on a traditional object-oriented and, worse, framework-based approach.

- *Affordability.* The building blocks of *DNA* are available at a very affordable price or even, in some important cases, for free, whereas *CORBA* and *Java* enterprise software is mostly exorbitantly priced. Additionally, *DNA* is based on the *Wintel* platform, whose price-performance ratio currently seems to be much better than that of other platforms.

Currently, many client/server development efforts will probably be guided by ratiocination similar to the above when making their strategic decisions.[2464] Of course, this is not to say that *DNA* is without faults and weak points or that the alternative architectures do not have their place and benefits and may not once upon a time become fully supported by affordable products. In particular, *DNA* more or less posits a strategic commitment to the *Wintel* platform, which some will find impossible or unpalatable. Additionally, as *Java, CORBA,* and *COM/DNA* may be combined in many interesting ways, the choice between these infrastructures may often turn out to be considerably less stark than one may be tempted to believe at first sight.[2465] At any rate, below I will occasionally discuss interesting developments in the competing architectures as well. Although I indeed believe that *DNA* as a whole has a lead over its challengers currently, the client/server marketplace is very competitive and will remain so for the foreseeable future.

This study makes no pretensions to completeness, as it has been written with a very clear-cut objective, which in the main has determined the selection of covered topics, viz. to investigate if and how *Newi*-style business objects can be implemented on the underpinnings provided by a component-based client/server infrastructure, such as *DNA*.[2466] For one thing, this is the background to our rather extensive treatment of the *XML* and *MOM* technologies. Although this point of view has acted as a winnower of topics and facts, this will not be the place to present the results of this inquiry. On the contrary, we will, for nonce, confine our task to the much humbler one of presenting *DNA* as such and postpone the examination of its suitability as a business objects infrastructure to a future study. The reader will be expected to have a working knowledge of *COM/ActiveX* fundamentals.[2467]

2464 See, for example, [Dolg99b] p. 40 et seq. for a line of argument similar to the one given above.

2465 Cf. [RC98].

2466 [Sims94] is the seminal work on this kind of business objects.

2467 For a grounding in *COM/ActiveX,* see [Kirt99] p. 17 et seqq. or p. 54 et seqq above.

1.1. WHAT IS *DNA?*

DNA (Distributed interNet Application Architecture) is an umbrella term for a large number of *Windows*-based services and technologies useful for building distributed systems for the *Internet* as well as for intranets and local networks.[2468] *DNA,* which was introduced at *Microsoft's Professional Developers Conference* in September 1997, is an attempt at an overriding enterprise strategy comparable to *Sun's Java* strategy – in particular *Java for the Enterprise* – as well as *OMG's CORBA* effort. It comprises technologies that aim at rendering the *Windows NT* platform a formidable competitor in the enterprise computing domain still dominated by costly mainframe and minicomputer hardware and proprietary system software from *IBM* and a few other hardware manufacturers, such as *Sun, Hewlett-Packard,* and *Compaq/DEC/Tandem.* In order to achieve this, *DNA* includes a very large part of *Microsoft's* entire systems code base, including the technologies listed below:[2469]

1. *Windows platform*
   - *Windows* operating systems
   - *Microsoft Internet Explorer* – *Microsoft's* web browser
   - *Win32* technologies – the system programming *APIs* of *Windows*
2. *Component Object Model (COM)*
   - *COM* and related technologies – *Microsoft's* component technologies
   - *COM*-based industry specifications[2470]
3. *Presentation Services*
   - *HTML* and *Dynamic HTML*
   - Scripting
   - Components
   - *Win32* user interface
4. *Application Services*
   - *Internet Information Server (IIS)*
   - *Microsoft Message Queue Server (MSMQ)*
   - *Microsoft Transaction Server (MTS)*

[2468] [Micr97h], [Labo97], [Nich98], [Dolg98a], [Micr98n], and [HS98b] p. 7 et seqq. survey *DNA* from different points of view. [Brew97] deals with the *Active Platform,* which predates *DNA* as a concept, but, as we shall soon see, comprises many of the same technologies as *DNA*. In [Sess98a], Roger Sessions prefers the term *Microsoft Distributed Component Architecture (MDCA),* and in [Sess98d] he uses the term *Component-Oriented Middleware (COMware)* for the category of software to which most of the *DNA* constituents belong. [Kirt99] provides an excellent and technically detailed grand tour of *Microsoft's DNA* technologies, whereas [KS98] provides an extensive discussion of *Microsoft's* enterprise strategy and the rôle of *Windows 2000* (formerly *Windows NT 5)* in this strategy. Loosely related to *DNA* is *Microsoft's* notion of a *Digital Nervous System,* which, by the way, will be the topic of a future book by Bill Gates. In *Microsoft's* promotional materials, it is argued that companies with a *Digital Nervous System* will be more agile and will manage information better than those lacking one – they will "act faster", "react to anything", "make more informed decisions", "get closer to customers", and "focus on business, not technology". Furthermore, the building blocks of a digital nervous system will be a *PC* computing architecture, pervasive digitalisation of information, universal e-mail, ubiquitous connectivity, end-user productivity tools, and integrated business-specific applications. See http://www.microsoft.com/digital_nervous_system.

[2469] It should be noted that although the services of *DNA* partly overlap with the services offered by the *Windows NT Server* platform, these two service schemes are fundamentally different. The *NT* services (see http://www.microsoft.com/ntserver/nts/default.asp) encompass seven categories: file & print services, web services, application services, management services, security services, communication services, and media services.

[2470] These initiatives span the banking *(Windows DNA for Financial Services, DNA-fs),* engineering *(OLE for Design and Modeling),* health care *(ActiveX for Healthcare),* hospitality *(Windows Hospitality Interface Specification, WHIS),* insurance (*OLifE),* manufacturing *(Windows DNA for Manufacturing, DNA-M),* process control *(OLE for Process Control, OPC),* retail *(ActiveStore* and *OLE for Point-of-Sale, OPOS),* and the transportation and distribution *(Value Chain Initiative)* sectors.

5. *Data Access Services*
    - *Universal Data Access (UDA)*
    - *ActiveX Data Objects (ADO)*
    - *OLE DB*
6. *Windows System Services,* i.e. services provided by the *Windows NT Server* operating system
    - Directory
    - Security
    - Management
    - Networking and Communications
7. *Windows DNA tools*
    - *Microsoft Visual Studio* – includes *Microsoft's* programming languages, tools, and environments such as *Visual Basic, Visual J++, Visual C++, Visual FoxPro, Visual InterDev,* etc.[2471]
    - *Microsoft FrontPage* – a web page design tool
8. *Microsoft BackOffice*[2472]
    - *Exchange Server* – *Microsoft's* e-mail server
    - *Proxy Server* – provides secure *Internet* access through firewall and web caching functionality
    - *Site Server* – an intranet web server based on *Windows NT* and *IIS*
    - *Site Server, Commerce Edition* – a platform for *Internet* e-commerce
    - *Systems Management Server (SMS)* – tools for centralised management of networked computers, also providing support for distribution and inventory of software
    - *SNA Server* – offers connectivity with *IBM* mainframe and *AS/400* systems
    - *SQL Server* – *Microsoft's* relational database management system, which also comes in an *Enterprise Edition* with some added bells and whistles

In addition to the above building blocks, *Forms+, COM+,* and *Storage+* are potential future cornerstones of *DNA,* still under development – we will come back to them in due course. The *Windows* platform and *COM* provide, as it were, the foundation of *DNA.* The presentation, application, and data access services correspond neatly to the presentation, business logic, and data tiers that together make up the three-tiered architecture suggested in many documents concerning *DNA* – their correspondence to the future technologies *Forms+, COM+,* and *Storage+* should also be taken note of.[2473] As the code implementing business logic in the three-tiered scheme is executed on server machines rather than on the clients, this approach is sometimes said to be *server-centric* as opposed to traditional *database-centric* approach of two-tiered and two-and-a-half tiered[2474] architectures.[2475] Below, we will survey the *DNA* presentation, application, and

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[2471] [Micr98r] surveys the rôle of *Visual Studio* in the *DNA* architecture. Cf. also [Vaug98].

[2472] The *BackOffice* server products are bundled together in different suites, such as *Back Office Server, BackOffice Small Business Server,* and *Microsoft Commercial Internet System (MCIS).* For example, *MCIS* encompasses *Site Server, Commerce Edition* and support for *Internet* mail, news, and chat functionality.

[2473] [Sess98d] p. 22 suggests a *4TPC (Four-Tier Plus Component)* architecture that encompasses a web tier as well as the three "traditional" tiers (client, business logic, and data). In this model, the business logic tier is organised as components and is, hence, also referred to as the component tier. The "component" epithet in the designation of the *4TPC* architecture explains itself from the pivotal rôle of these business logic components, whereas the "plus" is motivated thus: "the Web page, the business logic, and the data tiers often involve a loosely connected confederation of machines that can be thought of as subpeer tiers".

[2474] The 2½-tiered variants use *stored procedures* and/or *gateways* to eschew some of the shortcomings of the two-tiered architecture.

[2475] [Micr98ϕ]

data access services, only occasionally concerning ourselves with systems services, tools, or the *BackOffice* products, which seem somewhat peripheral to our subject.

1.2.22 THE *ACTIVE PLATFORM*

The *Active Platform* is another umbrella term occasionally used for *Microsoft's* platform for *Internet* development. It comprises the *Active Client,* the *Active Server,* and *ActiveX,* each of which, in turn, includes a plethora of technological building blocks.[2476] The terms *Active Platform, Active Client,* and *Active Server,* which all predate *DNA,* are not very much used in recent *Microsoft* writings, and also the use of the term *ActiveX* has become much more restricted than it used to be; nowadays, *ActiveX* is almost exclusively used with reference to the *ActiveX Controls* user interface components and a few other related technologies.

The *Active Client* essentially supports the functionality provided through the *WebBrowser* part of *Internet Explorer,* including *HTML,* scripting (in *VBScript* and *JScript*), and components, such as *ActiveX Controls* and *Java applets.* The *Active Client* is available also for non-*Windows* platforms such as the *Macintosh* and various *UNIX* dialects through the *Internet Explorer* implementations for these environments.

Active Server is a blanket term for *Microsoft's NT*-based server-side web technologies and encompasses web services, component and transaction services, directory and security services, data management services, and network services.[2477] Similarly to the *Active Client,* the *Active Server* provides support for the three fundamental constituents *HTML,* scripting, and components (in this context called *Active Server Components*). It does so primarily through the *Active Server Pages (ASP)* technology of *Microsoft's* web server *Internet Information Server (IIS),* which is the cornerstone of the *Active Server* platform. Additionally, the *Active Server* includes various parts of the *Windows NT Server* operating system (e.g. directory and security services and *Active Server* system management), the *Microsoft Transaction Server (MTS),* and database access through *ODBC* and *OLE DB* and remote object access through *DCOM.*

[2476] See [Winn97a], [Vaugh97], [PM97] p. 58 et seq. and [Brew97].

[2477] *Microsoft Component Services* is a more recent term for largely, but not exactly, the same technologies: *COM/DCOM, MTS, IIS,* and the *Microsoft Message Queue (MSMQ)* are subsumed by this concept. See [Micr98v].

1.2. PRESENTATION SERVICES – HARMONISING THE *GUI* AND THE *WUI*

The success of the world wide web has created a noticeable cleft between two kinds of user interfaces, to wit the rudimental, hyperlink-oriented *HTML* interface of the web browser page – we will refer to this as the *Web User Interface (WUI)* from now on – and the highly evolved *WIMP (Windows, Icons, Menus, Pointers)* interface of the state-of-the-art *Graphical User Interface (GUI)* application, studiously observant of the *GUI* guidelines of its platform[2478] as well as of the latest *GUI* fashion novelties and gimcracks. By the use of *Java* applets, it will be possible to confer a richer graphical interface and improved interactivity upon a web page, but unfortunately, *Java* applets are not problem-free either. Firstly, applets are known to incur a considerable cost as far as performance is concerned – a cost that consists of download time, load time for the *Java* virtual machine, and execution time overhead. Secondly, the limitations imposed by the much pursued, but hitherto elusive goal of user interface and operating system portability as embraced in the very comprehensive class libraries and frameworks of *Java,* tend to hamper *Java* functionality to a *least common denominator.*[2479] Consequently, *Java* applets often impart a drab and botched impression that falls far short of the dernier cri in *GUI* look and feel. Frequently, applets even exhibit erratic or anomalous behaviour because of the unfeasibility of testing all different combinations of web browsers, *Java* virtual machines, user interface and hardware platforms, display resolutions, etc. Although much work is going on to enhance the performance of *Java* and the user interface functionality supported by the recent *JFC (Java Foundation Classes)* framework is much richer than that of the original *AWT,* these developments will only alleviate, not dispel the problems indigenous to the *Write Once, Run Anywhere (WORA)* approach.[2480] In *Microsoft's* view, *Java* is excellent as a *programming language* – in particular, it turns out to sort exceptionally well with *Microsoft's* own *COM*[2481] –, but the attempt to make it a *portable operating system* built on top of the multitude of native operating systems is a fallacy, since this approach by its very nature will both incur an intolerable performance overhead and result in impaired functionality.[2482]

Microsoft's user interface strategy aims at the reconciliation of the *Windows GUI* and the web user interface, the *WUI.* The rationale behind this strategy is at least twofold: Firstly, both types of user interfaces will profit from such unification. The web interface may reach the level of sophistication and usability that users are wont to expect from *GUI* applications and will conform to the same rules as these. The operating system *GUI* will profit from the addition of *WUI*-style hyperlinks to local and remote data, as can be seen from the nifty integration of such linking capabilities in e.g. *Microsoft's Office* suite and the *Active Desktop.* Secondly, in the future most software will be web-enabled to at least some extent, although it will still need to support a traditional *GUI* as well and, doubtless, *GUI* execution will remain the rule for many types of applications.[2483] In

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[2478] Such as [Micr95b], the *Windows* interface guidelines.

[2479] Traditionally, there have been two approaches to user interface portability: The most straightforward approach will be to build a portable library that internally uses the native *GUI APIs* – this implies that the functionality of the portable library is reduced to the *least common denominator* of the native *APIs.* Alternatively, one may bypass the native *APIs* altogether, except for the most rudimentary graphical rendering functions, and build one's own *GUI API* from the ground up. In this way, it will be possible to implement a library that supports a *largest common denominator* of the system *APIs.* Libraries taking this approach – such as *Galaxy* and *OpenInterface* – generally lets the user select the *GUI* style of an application regardless of which platform the application executes on. For example, it may be possible to select a *Windows* look and feel for a programme running on a *Macintosh* and a *Motif* look and feel for an application executing in *Windows.* However, *look and feel* involves not only visual appearances, but also the behaviour of applications, and behavioural issues are very hard to come to terms with through a portable library.

[2480] *Microsoft* has announced that it has no intent of supporting the *Java 2 platform* (formerly *JDK 1.2),* of which the *JFC* classes are part, in its own *Java* virtual machine, which is used in *Internet Explorer* and *Visual J++.* This will possibly thwart a wide acceptance of the *JFC* framework for web development purposes.

[2481] Paradoxically, it may well turn out that *Microsoft's Java* implementation will replace *C++* as the language of choice for *Windows* systems programming. Cf. [Chap96b] p. 301 et seqq. and [Sess97c]. As a language, *Java* comes surprisingly close to the age-old *Simula* language, the ancestor of all object-oriented languages. In any case, programming languages tend to become successful not because of their inner qualities, but because they at a particular moment in history solve a vital problem within an at the time important domain. *Java* filled the need for a web programming language mainly by virtue of its support of *byte code execution,* a neither original, nor essentially *Java*-specific language feature. Were it not for *Netscape's* adoption of the language in its web browser at the critical moment in history, *Java* would presumably have remained a shadowy experimental product.

[2482] [Kell98b] wryly, but aptly characterises *Java the Agenda* as "a fine mix of jihad and tulipomania". Indeed, the computing community seems prone to develop such pandemic fits of tulipomania at regular intervals.

[2483] [Swen98a] and other *Microsoft* documents refer to *Microsoft's* future web-enabled applications as *weblications.* These are believed to reduce "the need to focus on documents and file locations, thereby freeing users to think more about the information they are viewing or authoring" and "to eliminate today's concept of applications, by letting users perform tasks without consciously launching an application tailored to each task". *Money 98* provides an early example of a *Microsoft* "weblication", having a user interface largely built in *Dynamic HTML.*

many cases, if not most, it will be too costly to implement twain user interfaces, insofar as the user interface code frequently makes up the lion's share of an application. By unifying the *WUI* and the *GUI* into one uniform user interface, unnecessary development costs will be avoided – and usability, consistency, and flexibility will hopefully benefit at that.

The flip-side of this unification will be the resulting forfeiture of portability. In some cases, this will simply not do. For example, a commercial web site such as a web bookshop will probably want to be able to serve customers, regardless of which computer, operating system, and web browser they use, and hence will have either to put up with the strait-jacket of a portable user interface or to grapple with the complexities and costs of supporting multiple interfaces. Nevertheless, in other cases – typically intranets or extranets – the operating system of the clients may be known to invariably be *Windows* and the web browser *Internet Explorer,* and in yet others one may choose to ignore recusant clients. In the long run, the unification of the *WUI* and the *GUI* will probably not benefit the niche players on the client operating system market, although they may temporarily ward off the risk of being rendered irrelevant by makeshift techniques such as emulation.[2484]

In a *Microsoft* white paper on the *DNA* strategy[2485], four kinds of clients, ranging from "thin" to "rich" are distinguished, two of which are "page based" and two of which are "EXE based":

- *Browser Neutral:* "a basic Web application" with a simple standard *HTML* web page interface that offers maximal browser portability
- *Browser Enhanced:* "a dynamic Web application" with an enhanced web page interface, where *Dynamic HTML* and scripting are typically used to support dynamic content and interactivity without unnecessary network roundtrips and without recourse to slow *Java* applets or insecure *ActiveX* controls
- *Internet Reliant:* "a connected application", which, being a *Windows* executable, has full access to *Windows* system services and uses "a combination of HTML, DHTML, Scripting, and ActiveX controls to provide rich integration with the client system as well as full connectivity to remote services on the Internet"
- *Internet Enhanced:* "a connectable application" that targets the *Win32 API,* but implements aspects of *Internet* connectivity, such as, for example, embedded hyperlinks, hosting of *Internet Explorer* for display of *HTML/DHTML* pages, or download of updates across the *Internet*

Whereas *Browser Neutral* and *Browser Enhanced* pages are legion today – the latter ones are, for instance, profusely provided at *Microsoft's* own web site[2486] – and *Internet Enhanced* applications are impersonated by *Microsoft's Office* and *Visual Studio* products, the *Internet Reliant* application type may seem a strange creature. However, *Microsoft Money 99* does flesh out this category, which is expected to become increasingly important through the introduction of the *HTML Application (HTA)* technology of *Internet Explorer 5.0.*[2487]

Today, there are quite a few technologies to choose from when building a web user interface. These include:

- *HTML*
- *Java applets*
- *JavaBeans*
- scripts written in scripting languages such as *JavaScript/JScript* or *VBScript*

[2484] The porting of *Internet Explorer* and core parts of *COM* to operating systems other than *Windows* may also mitigate this risk somewhat. Currently, versions of *Internet Explorer* are available for *Apple Macintosh, Sun's Solaris,* and *Hewlett-Packard's HP-UX.*

[2485] [Micr98n]. [Rauc98] is a slightly different version of this white paper.

[2486] http://www.microsoft.com

[2487] See http://www.microsoft.com/money/default.htm.

- *Dynamic HTML*
- *DHTML scriptlets*
- *XML scriptlets*
- *DHTML Behaviors*
- *ActiveX* controls

Out of these, *VBScript, DHTML scriptlets, XML scriptlets, behaviors,* and *ActiveX* controls are essentially proprietary *Internet Explorer* technologies, although some of them will be available also to the users of *Netscape Navigator* through plug-ins from *NCompass Labs.* As for *Java* support, *Microsoft* is ostentatiously Laodicean about *JavaBeans* and has pugnaciously declared its own lack of intent to support the *Java 2 platform* at all. In theory, it will be possible to exchange the default *Microsoft*-provided *Java* virtual machine of *Internet Explorer* against, for example, the one provided by *Sun* and relied upon in *Netscape Navigator,* although those willing to take such a brave step may be expected to be few. Additionally, *Netscape* and *Microsoft* provide incompatible interpretations of *Dynamic HTML,* although, in this case, *Microsoft's* variant is much more far-reaching and innovative than that of *Netscape.* As long as neither *Netscape Navigator,* nor *Internet Explorer* has the whip hand over the browser market, the dull clinch between the two competing camps will presumably go on, effectively blocking the avenue towards more functional web pages.

Apparently, *Microsoft* attempts to bring the pieces of weaponry that were crucial to its desktop successes – components, *Rapid Application Development (RAD),* close integration with the *Windows GUI* – to bear also on the web. The vision resulting from this attempt is, of course, entirely at odds with the *Java*-centric strategy zealously promulgated by the so-called *NOISE (Netscape, Oracle, IBM, Sun, and Everyone else)* group, a posse of companies doggedly hostile to *Microsoft's* plans.[2488]

1.2.23 INTERNET EXPLORER

Below we will discuss the architecture and technologies of *Internet Explorer* at considerable length. *Internet Explorer* is not only worthy of a detailed study, because it happens to be *Microsoft's* web browser and one of the two main contenders in the ongoing "browser war", but much more so since it is a vital part of a grandiose design to unify the worlds of the personal computer and the web on the foundation of software components, and since it in itself is an impressive tour de force in the componentisation of software. To boot, *Internet Explorer* is one of two cornerstones – the other one is, of course, *Win32* – of the presentation services of *DNA.*

1.2.23.1 The Origin and Early History of Internet Explorer

The concept of the web browser was originally suggested in 1989 by Tim Berners-Lee in a paper intended for internal circulation at *CERN,* where Berners-Lee was then employed.[2489] In late 1990, Berners-Lee himself developed the first implementation of a web browser and web editor – dubbed the *World Wide Web* by its author – on a *NeXT* machine at *CERN.* Pari passu, he devised the other fundamental building blocks of the web: The page definition language *HTML (Hypertext Markup Language),* the wire protocol *HTTP (Hypertext Transfer Protocol),* and the *URL (Universal Resource Locator)* addressing scheme. Although Berners-Lee's graphical, point-and-click, hypertext-like browser was operative by the Christmas of 1990, it was not until 1993 that the real breakthrough of the web took place, as the *Mosaic* web browser became available in versions for *Windows, Macintosh,* and *UNIX,* and it was not until December 1993 that the web was first noted as a phenomenon of wider interest by publications such as *The New York Times, The Guardian,* and *The Economist.*[2490] *Mosaic,* which added pictures to Berners-Lee's conception of a text-oriented web browser, was developed by the under-

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2488 [Winn98a], [WM98], and [Edwa98a] are some *Microsoft* papers discussing the merits of the different approaches.

2489 [Bern89]. [HL96] gives an account of the *Internet* from its early origins. Interesting materials on the history of the web is maintained by the *Internet Society* at http://info.isoc.org/internet-history. More historical links are available at http://www.elsop.com/wrc/h_web.htm. [Niel95] p. 165 et seqq. et passim discusses the *Internet* as a hypertext medium.

2490 [W3C95]. According to [Zako98], the service traffic of the *WWW* this year grew at the astounding rate of 341,634%!

graduate student Marc Andreessen, the staff programmer Eric Bina, and a few other developers working for the *National Center for Supercomputer Applications (NCSA)* of the *University of Illinois* in Urbana-Champaign.[2491] The key *Mosaic* developers were persuaded in early 1994 by Andreessen, who by then had graduated from the university, and Jim Clark, a venture capitalist and founder of *Silicon Graphics*, to move over to *California* and start working for their newly founded company *Mosaic Communications*. The appropriation of the name *Mosaic,* the corps of *Mosaic* programmers, and allegedly the source code of *Mosaic* as well, which is rumoured to have formed the basis of the first version of *Navigator* – betraying itself through error messages that referred to *NCSA* or *Mosaic* – caused a legal dispute, which was settled in late 1994 by an agreement that *NCSA* was to be reimbursed by the sum of $2.7 million for the sustained damages and that *Mosaic Communications* would change its name into *Netscape Communications.*

By this time, *Netscape* was already about to get the upper hand over the browser market by the release of the first version of *Navigator* and was approached by *Microsoft* about licensing *Navigator* for inclusion in a coming *Windows 95* upgrade. *Microsoft's* siren strains were, however, rejected by *Netscape,* and, in late 1994, *Microsoft* instead licensed *Mosaic* from *Spyglass,* a Chicago company formed by former *NCSA* engineers, who had acquired the distribution rights of *Mosaic* from *NCSA.* Apparently, *Microsoft,* which was then working hard on the promotion of its own on-line service *MSN (Microsoft Network),* was taken aback by the sudden ascent of the *World Wide Web (WWW)* and the *Internet* in 1993-1994, and realised that in order to swiftly get a web browser to ship with *Windows 95* it had to purchase it rather than to develop it from scratch. The first two versions of *Internet Explorer,* both released during 1995, were basically but dandified versions of *Mosaic,* and it was not until the 4.0 version of *Explorer* that the *Mosaic* residual became altogether insignificant. In 1995, *Netscape* had already secured a firm grip of the browser market and for a period maintained a market share of 80-90%, which, however, since has steadily declined because of the increasingly severe competition from *Internet Explorer.*[2492] Today (late 1998), *Explorer* and *Navigator* may be estimated to have about equal market shares (40-60%), although the exact numbers are subject to dispute.

As *Windows 95* finally was out of the door, *Microsoft* embarked upon a relentless effort to take back the terrain lost during the initial spell of negligence of the decuman *Internet* wave.[2493] *Microsoft's* "embrace and extend" strategy – by the way, a classical strategy amongst suppliers of "open systems" and already successfully applied by *Netscape* – and of close integration with the *Windows* operating system was presented in a famous speech made by Bill Gates on 7 December, 1995, the 45th anniversary of the Japanese assault on Pearl Harbor.[2494] *Microsoft* has since invested huge sums in the development of its *Internet* technologies, the cornerstone of which is *Internet Explorer,* and the pervasive integration of *Internet* functionality with the *Windows* operating system and the key *Windows* applications.

We will now go on to discuss the interesting, not to say groundbreaking, component-based web browser architecture introduced by the release of *Internet Explorer 3.0* in August 1996.[2495] In our treatment we will chiefly be concerned with the 4.0 version of *Internet Explorer*, although we will give some tidings about its version 5.0 as well, which is slated for release on 18 March 1999.[2496]

[2491] [Scot98], [Andr97b], and [Wagn97] recount the rather sombre family drama involving the three close relatives *NCSA Mosaic, Netscape Navigator,* and *MS Internet Explorer.* [Ragg98] and [Andr97a] give two very different views of how the credits for the original ideas of *Mosaic* should be distributed. [CY98] provides a comprehensive analysis of *Netscape's* successes and failures.

[2492] [CY98] p. 9 et seqq.

[2493] In *The Road Ahead* [Gate96] p. 38 et seqq., Bill Gates makes the observation that computer companies that have become successful through a new wave in computing tend to miss the next big wave. The fear of being rendered obsolete by such a new wave seems to present a major incitement to Mr. Gates and *Microsoft* to be more agile and sensitive to new trends than some once very successful, but now dethroned computer companies.

[2494] [Gate95]. Gates' citing of the Japanese admiral Yamamoto's observation that he feared that the Japanese had awakened a sleeping giant has been widely noted and commented upon. For all its attempts to tie the *Internet* and *Windows* together, *Microsoft* has been able to establish good rapport with the web standardisation bodies *W3C* and *IETF,* which were largely ignored by *Netscape* during its golden days. In contrast, *Microsoft* has been noticeably agog to adopt their recommendations, apparently being quite keen to outpace *Netscape* in the standards compliance race.

[2495] *Apple's OpenDoc*-based *Cyberdog* browser also used a component-based architecture. See [MS96] p. 198 et seqq. [Lam98] discusses how to build "componentware applications" with *OLE* and *Netscape Navigator.*

[2496] We will here only be concerned with the full *Win32* version of *Internet Explorer.* The limitations incidental to the versions of *Internet Explorer* for *Windows 3.1, Macintosh,* and *UNIX* are accounted for in [Winn98b].

1.2.23.2 The Architecture of Internet Explorer

Just like the rather obscure *Office Binder* of *Windows 95, Internet Explorer* is an *Active Document container*, which is to say that it may host documents created in applications that are capable of acting as *Active Document servers,* such as *Word, Excel,* or *PowerPoint.*[2497] This kind of hosting is closely related to the technique of *in situ* editing of embedded documents of *OLE,* although it differs from embedding by providing the *Active Document server* with a *frame* of its own in which to display the *Active Document* inside the container application as well as with more complete control of the container. When a document associated with an *Active Document server* is opened in *Internet Explorer,* it will almost appear to the user as though it were opened in its native application, and the user will be able do well-nigh anything he can do in the application proper. Software suppliers who want a certain document format to be supported by *Internet Explorer* may implement an *Active Document* server for this format, just as they may implement a plug-in for *Netscape Navigator.*[2498]

Actually, the picture is somewhat more complicated.[2499] For one thing, *Internet Explorer* is built from a number of components, the most important of which are:

- the host programme *IEXPLORE.EXE*
- the *WebBrowser control SHDOCVW.DLL*
- *Microsoft's HTML* viewer *MSHTML.DLL,* or *MSHTML* for short

Save for a *GUI* frame and a toolbar for the *WebBrowser control,* the *Internet Explorer* executable *IEXPLORE.EXE* by itself contains very little functionality. The *Explorer* executable and the *WebBrowser control* interoperate through a number of *COM* interfaces, and, in principle, it would be possible to provide an alternative *WebBrowser control.*

The *WebBrowser control* caters to the fundamental browser functionality, such as navigation by *URL (Universal Resource Locator)* or by hyperlink through *in-place linking,* which is a term used to denote the ability to click on a link in a document in order to have a new document loaded inside the same *WebBrowser control.* Other basic capabilities supported include data download, handling of history lists and favourites, security, and *PICS (Platform for Internet Content Selection)* content screening. The *WebBrowser control* is an *Active Document container* and may host any *Active Document server* in order to display a certain type of document, such as *MSHTML* for *HTML* documents, *Word* for *Word* documents, *Excel* for *Excel* spreadsheets, etc. In addition, the *WebBrowser control* is an *ActiveX* control and, hence, may be used in any application capable of acting as an *ActiveX* control container. This makes it possible to take advantage of the *WebBrowser control* in, for instance, a *Visual Basic* or *C++* application – indeed, a poignant illustration of the power of components.[2500]

The *WebBrowser control* exposes methods, properties, and events, and it is possible to programmatically select which browser elements (menus, address bar, toolbar, status bar) are to be visible as well as to control most of its behaviour and properties, including navigation, printing, saving, sizing of the browser frame, etc.[2501] For instance, it will be possible to customise the *context menus* that appear upon right-click, to restrict downloading, or to provide one's own *security manager.* Event handlers may be written for events such as *DownloadBegin* or *DownloadComplete.* It should also be noted that the *WebBrowser control* is itself not only an *ActiveX* control, but also an *ActiveX* control container and, thus, may host other *ActiveX* controls.

MSHTML is *Microsoft's* parsing and rendering engine for *HTML,* or rather the extended *Dynamic HTML* flavour of *HTML.* It also exposes the *Document Object Model* of the page as a hierarchy of *automation objects* (with

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[2497] See [EE98b] p. 241 et seqq. and [Chap96b] p. 266 et seqq. In the latter work and in some other treatments, *Active Documents* are referred to as *ActiveX Documents.* They are also known as *OLE Document Objects* or simply as *DocObjects.*

[2498] *NCompass Labs' docactive* is a *Netscape Navigator* plug-in that makes it possible to view *Active Documents,* including *Microsoft Office* documents, in *Navigator.*

[2499] See [Micr98w], [Winn97b], and [Chap96b] p. 274 et seqq.

[2500] In this context, the *WebBrowser control* is sometimes referred to as *Microsoft Internet Controls.* It is also possible to use *Internet Explorer* as an *automation server,* in which case *IEXPLORE.EXE* rather than the *WebBrowser* control acts as the server.

[2501] Cf. [Lass98].

methods, properties, and events), starting with a top-level *Window* object, which contains a *Document* object that, in turn, holds the entire tree of elements rendered on the page.[2502] *MSHTML* is implemented as an *Active Document* server, which may be hosted by the *WebBrowser control* or indeed any *Active Document container.* In most cases, it will be more convenient to reuse the *WebBrowser control* rather than *MSHTML* in order to avoid having to re-implement the functionality the *WebBrowser control* provides. An *HTML* page may be divided into different frames. In this case, each frame will recursively host another instance of the *WebBrowser control,* which, in turn, will host *MSHTML* or another *Active Document server.* Just as is possible with reference to the *WebBrowser control,* one may control various aspects of the *MSHTML* component programmatically, such as its menus, toolbars, and other user interface paraphernalia. The *MSHTML* component is capable of hosting a variety of interesting items, such as:

- *ActiveX Controls,* including *Microsoft's* implementation of the *Java virtual machine*
- *ActiveX Script* engines for scripting languages such as *Visual Basic Scripting Edition* (also known as *VBScript)* or *JScript, Microsoft's* implementation of the *ECMA-262* standard for *JavaScript*
- *Java applets,* hosted through *Microsoft's JVM (Java Virtual Machine) ActiveX Control*

We will now discuss these three elements, *ActiveX Controls,* scripts, and *Java* programmes, before we return to the topic of *Microsoft's Dynamic HTML,* which we will then look into somewhat more closely.

1.2.23.3 ActiveX Controls

The *RAD (Rapid Application Development)* programming style fostered by the combination of visual components and easy-to-use visual programming environments, the archetypal example of which will be *Visual Basic* and its *VBX* and *OCX* components*,* has arguably been instrumental in the successes of *Microsoft.*[2503] It stands to reason that such components will come in handy also in the design of web interfaces and web applications, although the perspective of execution in the web environment will make it necessary to rethink various aspects of the technology. As a matter of fact, it was in order to make the refurbishment of this technology for the web manifest that *Microsoft* in early 1996 renamed the visual components then known as *OLE Controls* (or *OCXs) ActiveX Controls.* The main web adaptations made appertained to:

- downloading of controls over the *Internet*
- reduced memory footprint of controls
- security by *trust verification, digital signing,* and *marking*
- asynchronous loading of the persistent data of controls

MSHTML, Microsoft's HTML engine, is an *ActiveX* control container and, hence, capable of entertaining any number of *ActiveX* controls.[2504] An *ActiveX* control is inserted on an *HTML* web page through the *OBJECT* tag, inside which are specified the *CLSID* of the control (as a *CLASSID* attribute), an *ID,* which is a name that may be referred to in scripts, and various other attributes such as the dimensions of the screen estate assigned to the control, as illustrated by this example:

[2502] An *automation object* supports the dynamic discovery and access of its *methods* and *properties* by implementing the *COM* interface *IDispatch.* An application containing *automation objects* is known as an *automation server* and one using such objects as an *automation client. Microsoft,* being in the habit of constantly reforming the terminology of its component technology, has – in vain, for sure – tried to replace the term *automation object* with *ActiveX object* or simply *object* and the terms *automation server* and *automation client* with *ActiveX component* (or the unwieldy *ActiveX component acting in the role of a server)* and *ActiveX client* (or *ActiveX component acting in the role of a client*)*,* respectively. See [Chap96b] p. 85 et seqq. and [Broc95] p. 635 et seqq. for an explanation of the mechanisms of *Automation.*

[2503] The standard work on *ActiveX* controls is [Denn97], which treats of the *Internet* aspects of the technology on p. 395 et seqq. Cf. also [Chap96b] p. 265 et seqq., [EE98b] p. 139 et seqq., and [Plat98] p. 365 et seqq. and the very ample database of information available as *Microsoft SiteBuilder Workshop* at http://www.microsoft.com/workshop/default.asp.

[2504] Support for *ActiveX* controls and the scripting of such controls may be added to *Netscape Navigator* through *NCompass Labs' scriptactive* plug-in.

```
<HTML>
<TITLE>ActiveX control</TITLE>
<BODY>
<OBJECT CLASSID="clsid:2677E6E0-7D95-11d2-BCEE-E842F8000000"
        CODEBASE="http://www.dna.lth.se/epers/magic.cab"
        ID=ExampleControl HEIGHT=125 WIDTH=125>
<PARAM NAME="MagicNumber" VALUE=211>
</OBJECT>
</BODY>
</HTML>
```

In the *HTML* page may also be included script event handlers, which will be executed when a particular event is triggered by the control. Scripts may reference and use the methods and properties exposed by the control freely. It is also possible to access the *Dynamic HTML* object model of the web page from inside the control through the *IHTMLDocument2 COM* interface.[2505]

When *MSHTML* lights upon an *OBJECT* tag referring to an *ActiveX* control, it will attempt to create the control through the *COM API* function *CoCreateInstance*. If a *CODEBASE* attribute specifying the *URL* of the *ActiveX* control has been entered into the *OBJECT* tag, *MSHTML* will, however, first download the control from this *URL* by calling *CoGetClassObjectFromURL*, provided the control is not already installed locally.[2506] Optionally, a version number may be given in the *CODEBASE* attribute, causing a download to take place only if the locally stored *ActiveX* control has a lower version number than that given in the attribute. Download takes place through the *Internet Component Download* service, which also performs certificate checking and installation of the downloaded components, as we shall soon see.

The file specified by *CODEBASE* may in the simplest case be a single *executable* .OCX, .DLL, or .EXE file. This method of downloading a single file is, however, neither flexible, nor efficient, since it does not offer any way to download an ancillary file, to specify registration information, or to differentiate between platform and language versions of the control, and no compression of the file is made during the download. Alternatively, an .INF *information file* may be given by the *CODEBASE* attribute. Such a file may specify *URLs* for several files to be downloaded from one or multiple machines as well as registration information for these, and may add conditional installation instructions concerning, for example, which binaries are to be downloaded for different machine types. More complex dependencies may be specified through an *XML Open Software Description (OSD)* file, which may replace the .INF file, although support for *OSD* is only available in *Internet Explorer 4.0* and later. Unfortunately, no compression is made of standalone *.INF* and *.OSD* files; nor can these be digitally signed so as to make trust verification possible.

Although the tacks described so far are all perfectly licit, the course recommended by *Microsoft* is to package all the files that need to be downloaded for a certain task into a single *distribution unit,* also known as a *cabinet file*. A *cabinet file* (having a .CAB extension) is a compressed[2507] package of zero or more executable files and an .INF and/or an .OSD installation script.[2508] The *cabinet file* may – and, of course, ought to – be signed in order to enable trust verification. It should be noted that it is legal for the *cabinet file* not to hold any executables at all, but that it must always contain at least one .INF or .OSD file. This is reasonable, if, for example, different cabinets are to be downloaded for different platforms and languages in accordance with instructions given in the .INF or .OSD file.

Download time is a resource that should be used with the greatest parsimony, although we should keep in mind that an *ActiveX* control will only need to be downloaded the first time it is used and then remains

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[2505] See [Micr98y]. The control will need to support the *IObjectWithSite* or *IOleObject* interface to do this easily.

[2506] See [Edwa98b] and [Chap96b] p. 296 et seqq.

[2507] The compression format is known as MSZIP and is based on the Lempel-Ziv data-compression algorithm.

[2508] If both are available, the .OSD file will take preference, but may need to rely upon the .INF file for making *Windows* registry entries, which is beyond the capabilities of an *OSD* file. An *OSD* file can, however, handle more complex dependencies than an *information file,* including language dependencies, and may also be used together with a *CDF (Channel Description Format)* description in order to set up a *Software Delivery Channel* (sometimes called a *Software Update Channel)* that automatically will inform users of updates of a software component. *Internet Explorer 5.0* will feature yet another file type called *catalog files,* which may be used to describe a set of files as a logical group in order to avoid multiple trust dialogues during complex installation tasks.

installed on the computer. Nevertheless, in order to reduce the memory footprint of controls, *Microsoft* chose to radically dilute the requirements that must be met by a component to qualify as an *ActiveX* control, as compared to those once established for an *OCX,* which according to the original *OLE* specifications had to support a very large number of *COM* interfaces.[2509] To qualify as an *ActiveX* control, a *COM* object now only has to implement the *IUnknown* interface and support *self-registration,* i.e. implement the two functions *DllRegisterServer* and *DllUnregisterServer.*[2510] It must also have an associated server that supports its creation through either of the interfaces *IClassFactory* or *IClassFactory2,* and it is strongly recommended that it should be "aware" of the *apartment* threading model.[2511] For an *ActiveX* control container to be able to check out the capabilities of the control, the control must announce which *component categories* it supports through registry entries containing the proper *category identifiers (CATIDs),* i.e. *GUIDs* indicating that a particular set of interfaces are supported and possibly that some other requirements are fulfilled as well.[2512] There may also be registry entries for categories, which the control requires the container to support.[2513]

For web components, another major concern is security. Whereas *sandboxing* may be used to prevent a *Java applet* from doing anything potentially harmful, such as a system call, it will not be feasible to check the operations of *ActiveX* controls for safety, since *ActiveX* controls are binaries, not byte codes or programme text. To bestow a reasonable amount of credibility upon an *ActiveX* control, it is instead possible to take advantage of a technique called *trust verification,* which is implemented by *Microsoft's Authenticode* mechanism, currently in its version 2.0.[2514] In order to do so, the provider of the control will first have to acquire a *Software Publisher Certificate (SPC)*[2515] from a recognised *Certificate Authority (CA)*, such as, for example, *VeriSign* or *GTE CyberTrust*. Before issuing the certificate, the *CA* will check the provider's credentials and demand a pledge of him regarding the non-malicious nature of his programme code. Having obtained the certificate, the provider may use the *SIGNCODE* utility of the *ActiveX SDK* to digitally sign *ActiveX* controls.[2516] A signed control will carry a *signature block,* which is used to verify the *authenticity* and *integrity* of the control – i.e. that the provider is trusted and that the control has not been tampered with.[2517] When the control has been downloaded, *Internet Explorer* – or rather the *CoGetClassObjectFromURL* function used by *Explorer* – will call the *WinVerifyTrust* function, which performs the verification. In case the trust verification fails or the *ActiveX* control was not signed, the user will be presented with the option to install the control anyway, provided his *Internet Explorer* security settings will allow this. It should be noted that trust verification may be used also with some other

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2509 [Denn97] p. 99 mentions 17 interfaces that must be implemented by *OLE Controls 94*-compliant controls *(IClassFactory2, IOleObject, IDataObject, IViewObject, IPersistStorage, IOleInPlaceActiveObject, IOleCache, IPersistStreamInit, IOleControl, IConnectionPointContainer, IConnectionPoint, IProvideClassInfo, IPropertyNotifySink, ISpecifyPropertyPages, IPerPropertyBrowsing, ISimpleFrameSite,* and *IDispatch* – actually, Denning seems to have omitted *IOleInPlaceObject* and *IRunnableObject!* Cf. also [Broc95] p. 1109, [Micr98z], and [Micr98α]. *OCX 96* (also referred to as *OLE Controls 96 or OC96* for short) added another set of interfaces (such as *IPointerInactive, IOleInPlaceObjectWindowless, IViewObjectEx,* and *IQuickActivate),* some of which were intended to speed up the use of *ActiveX* controls on web pages. The implementation of these interfaces will, however, add to the total size of the control and, thus, affect download time adversely. See [Micr98y] and [Denn97] p. 132 et seqq. and p. 150 et seqq.

2510 The control must register all standard registry entries for embeddable objects and automation servers, all component categories that it supports, and the component categories it requires its container to support.

2511 See [Micr98y] and [Denn97] p. 414 et seq. Cf. also [Smit98] and p. 587 infra.

2512 See [Chap96b] p. 206 et seqq. and [Denn97] p. 411 et seqq.

2513 Doubts may be cast upon the salubrity of this approach to downsizing. For one thing, minimalist *ActiveX* controls may download fleetly, but will also be minimally useful. Secondly, the reliance upon category checking will be both error-prone and resource-consuming and certainly has the potential to cause containers and – to a lesser extent – controls to be inundated by a spate of complex code for handling the ensuing combinatorial explosion of category settings.

2514 See [Plat98] p. 378 et seqq. [Micr96e], [John96], [Edwa98b], and [Micr97l].

2515 For the cognoscenti, the *SPC* is a *PKCS #7 signed-data object* containing the needed *X.509* version 3 certificates.

2516 It is possible to digitally sign .EXE, .DLL, .OCX, .CAB, and *Java* .CLASS files.

2517 The technical particulars are as follows: During the signing process, the binary code of the control is run through a one-way hash function that produces a 128-bit *cryptographic digest*. The *cryptographic digest* is *signed* – i.e. encrypted – with the software publisher's *private key*, which, by the way, should be kept hidden away at a very safe place. A *signature block* (packaged as a *PKCS #7 signed-data object)* is then put together from the *signed digest,* the serial numbers and names of the issuers of the publisher's *certificates,* and the *X.509 certificates* themselves. The latter will hold various pieces of information, such as the name of the publisher and, most importantly, his *public key*. Finally, the *signature block* is inserted in a reserved area of the control. Optionally, a timestamp may be added as well. When the *ActiveX* control is downloaded, the signature block is extracted and the publisher's *public key* is used to decrypt the *cryptographic digest*. The binaries of the downloaded control are run through the one-way hash algorithm, which produces another *digest*. If the two *digests* are the same, the code has not been tampered with. It is also possible to check that the certificate has not been revoked.

types of software, such as *Java applets*. A trusted *applet* will be liberated from the usual *sandboxing* restrictions and, thus, may access system services freely.

In case an *ActiveX* control, be it otherwise scrupulously well-behaved and supplied by the most trusted of sources, makes certain system calls such as disk accesses, a malicious hacker may "re-purpose" the control in a way that causes damage or harm by providing it with strange initialisation data or by writing scripts that use the control in an unforeseen, malevolent manner. A provider of an *ActiveX* control may *mark* the control as "safe for untrusted data" (also referred to as "safe for initialisation") and "safe for scripting" by either adding the relevant entries to the *Windows* registry or by implementing the *IObjectSafety* interface. Marking the control as "safe for untrusted data" amounts to offering a guarantee that regardless of which data the control is initialised with, it will function properly and cause no damage to the user's system. Marking the control as "safe for scripting" does the same with reference to the use a script makes of the methods, properties, and events of the control. If the control is not marked as safe, the user will be presented with warnings or may not be able to use the control at all, depending on the *Internet Explorer* security settings. A provider of a control should, of course, mark a control as safe only if it really is safe – and has undergone meticulous testing and verification. However, the temptation to mark the control as safe just in order to get rid of the annoying warnings will, unfortunately, be substantial.[2518]

When a control has been downloaded, it will need to load its persistent data. If the amount of data is small, it may be stored directly on the web page as *PARAM* elements under the *OBJECT* tag, granted the control supports the *IPersistPropertyBag* interface. This kind of instantiation is sometimes referred to as *persistent embedding*. For controls that support the *IPersistStream* interface, loading from a binary file can be achieved by specifying the *URL* of the file as the argument to the *DATA* attribute of the *OBJECT* tag. Such *persistent linking* will be more appropriate if the amount of data is comparatively large, although it will not work well for very large data files such as pictures, since control will be blocked, while the download takes place. In order to avoid blocking and bring about *progressive rendering*, there are – rather complex – mechanisms available that make it possible for a control to download its persistent data asynchronously and to obtain intermittent notifications about the arrival of new chunks of data.[2519] A *COM* object or an *ActiveX* control that handles instantiation of its persistent data over slow links reasonably is said to be *Internet-aware*.

Several important web-related technologies have been packaged as *ActiveX* controls by *Microsoft*. These include:

- the *Web Browser control* itself as explained above
- *Microsoft's Java Virtual Machine (JVM),* which is used to run *Java applets*
- the *XML* parser distributed as part of *Internet Explorer 4.0*
- the *DirectAnimation* multimedia controls for path control (moving *HTML* objects around on a web page), sequencing (complex manipulations of *HTML* objects), sprites (animated pictures), and structured graphics (vector graphics)[2520]
- the *Microsoft VRML (Virtual Reality Modeling Language) viewer* control developed by *Intervista,* allowing a user to view *VRML* 3-D graphics and traipse round the *VRML* worlds available on the *Internet*
- *Chromeffects,* an *XML*-based technology for creating animated 2-D and 3-D graphics with various multimedia effects such as sound and video[2521]
- the *Interactive Music Control* for creating and playing music [2522]

[2518] [Micr98β] provides some guidelines about what aspects should be considered before marking a component as safe.

[2519] See [Micr98γ] and [Chap96b] p. 293 et seqq. These mechanisms use an *asynchronous moniker,* viz. the *URL moniker*. See [Chap96b] p. 147 et seqq.

[2520] [Ledo98]

[2521] [Micr98∂]. In late 1998, this technology was put on ice. See [Fest98a], [Fole98c], and [Micr98y].

[2522] [Ledo97]

- *Microsoft Agent,* an eye-catching technology for creating conversational (i.e. natural language speaking and recognising) characters[2523]
- the *Windows Media Player Control* (formerly known as the *NetShow* control) for playing streaming and non-streaming multimedia content such as video and audio[2524]
- *Microsoft Chat Controls* providing chat functionality with or without a ready-to-use *GUI*[2525]
- the *NetMeeting* control, providing support for conferencing over the web
- the *ActiveX Script Control,* which may be used to add scripting support to an application
- the *Dynamic HTML Editing Component,* providing support for interactive editing of *HTML* pages
- the *Remote Data Service (RDS)* and *Tabular Data Control (TDC)* being, as we shall se below, useful when building client/server data access systems[2526]

1.2.23.4 ActiveX Scripting

ActiveX Scripting (formerly known as *OLE Scripting)* is *Microsoft's COM*-based architecture for script programming, or scripting for short.[2527] *ActiveX scripting engines* form a distinct class of components, each implementing support for the execution of scripts written in a particular *scripting language.* An *ActiveX scripting engine* may be used from any application or component that implements the *ActiveX Scripting host* interfaces. One important example of an *ActiveX Scripting host* is the *MSHTML* component of *Internet Explorer,* which by default comes with two *ActiveX scripting engines,* the one implementing *Visual Basic Scripting Edition,* which is a subset of *Visual Basic* often also referred to as *VBScript,* the other *JScript, Microsoft's* implementation of the *ECMA-262 (ECMA = European Computer Manufacturers Association)* standard for the syntactically *Java*-like *JavaScript* language.[2528] In addition to *Internet Explorer, Microsoft's* web server *IIS (Internet Information Server)* supports the hosting of scripting engines for *Active Server Pages (ASPs),* and the *Windows Scripting Host (WSH)* is a scripting host intended for use directly on the *Windows* desktop or at a command prompt, providing support for the analogue of *UNIX* shell scripts.[2529] Additionally, the *ActiveX Script Control* makes it easy to add scripting support to any *ActiveX* control container.[2530]

An *ActiveX scripting engine* will have to support the *COM* interface *IActiveScript,* which is used by the scripting host for various tasks, including registering the top-level objects of its own object model and starting the execution of a script. The script may either be handed over from the host to the scripting engine through the *IActiveScriptParse* interface or be loaded from persistent storage through *IPersistStorage* or another of the *IPersist** interfaces. Which of these interfaces the scripting engine implements, is not regulated by the *ActiveX Scripting* specification. If the scripting engine is to support events triggered by the host and let hosts access the methods and properties of a script, it must, however, implement the *IDispatch* interface as well.

[2523] [Micr98x]

[2524] The *Media Player* supports formats such as *Windows Media, Real Audio, Real Video, QuickTime, AVI, WAV,* and *MP3.* The *ActiveMovie* control was a similar *ActiveX* control replaced by the *Media Player* control.

[2525] There are three versions of the chat control: *Microsoft Chat Control* (comes with a user interface), *Microsoft Chat Protocol Control* (has no user interface), and *Microsoft Chat Java Applet* (applet with user interface).

[2526] See p. 615.

[2527] [Chap96b] p. 282 et seqq.

[2528] The syntactic similarities between *Java* and *JavaScript* are superficial – *JavaScript* is an entirely different language. *ActiveX scripting engines* implementing languages such as *PERLScript, PScript,* and *Python* are available from third-party software manufacturers.

[2529] *Active Server Pages* are essentially server-side *HTML* pages, including support for the *ActiveX Scripting* and *ActiveX Controls* technologies. See [Woda98] and infra p. 605. More details about the *Windows Scripting Host* are available in [Micr98κ].

[2530] [Micr98λ]. Both the *VBScript* and the *JScript* scripting engines may be licensed from *Microsoft* free of charge for inclusion in applications. There are versions of these engines for *Windows 3.1, Windows 95, Windows 98, Windows NT, Macintosh, HP-UX,* and *Solaris,* and in order to port them to other platforms as well one may license the source code from *Microsoft.*

For its part, the *ActiveX Scripting host* implements a *scripting site object* that supports the *IActiveScriptSite* interface. This interface supplies the scripting engine with a way to notify the host of errors and other circumstances as well as to access the top-level objects of the object hierarchies implemented by the host. Optionally, the *scripting site object* may implement the *IActiveScriptSiteWindow* interface in order to give the scripting engine access also to the window of the host application. The host objects accessible to the scripting engine may include *automation objects* as well as *ActiveX* controls. All these objects must implement the *IDispatch* and the *IProvideClassInfo* – or the *IProvideClassInfo2* – interfaces in order to expose their own methods and properties as well as their own type information to the scripting engine. If an object is capable of generating events, it must also support the *IConnectionPoint* and *IConnectionPointContainer* interfaces. The top-level object of the object model exposed by *MSHTML* is the *Window* object, which in turn holds the *Document* object that contains the entire hierarchy of elements of the *HTML* page.

Microsoft is currently taking great pains to develop its scripting technologies. For instance, support has been introduced for different kinds of *scriptlets,* i.e. script-based components[2531], as well as for *remote scripting,* which is a technology that will enable a script to asynchronously call the methods of server-based components and become apprised of the completion of these methods through callbacks. A plethora of tools for the script programmer has been crafted as well, including a *Scriptlet Wizard,* a script debugger, a script encryption tool, and a type library generator.

1.2.23.5 Microsoft's Java Implementation

The use of the *Java* components called *applets* on web pages brought the *Java* programming language front and centre. While preserving safety and portability by executing as portable *byte code* enshrined inside a shielding "sandbox" set up by the local *Java Virtual Machine*, these applets liberated web designers and programmers from the straightjacket of *HTML* and made it possible to create truly interactive web pages, superimposed with considerable *GUI* élan and versatility at that.[2532]

Microsoft's implementation of the *Java Virtual Machine (JVM),* the *Microsoft Virtual Machine,* is remarkable primarily for its close integration with *COM.*[2533] The basis of this integration is *Java's interface* construct, which meshes conspicuously well with *COM interfaces*, insofar as both a *Java* class and a *COM* object may implement multiple interfaces. The *Microsoft VM* will dynamically generate a *COM-Callable Wrapper (CCW)* for any *Java* object*,* when a *COM* interface is needed. The *CCW* supports a number of commonly used *COM* interfaces, such as *IDispatch* and *IUnknown*[2534]*,* as well as a class factory, thereby providing *COM* clients with easy access to the methods of the object as well as support for interface negotiation, reference counting, and object creation.[2535] From the coign of vantage of the *Java* programmer, this happens altogether clandestinely – he only sees and works with the ordinary *Java* object model.

2531 See below p. 557.

2532 [Saye98] points out an interesting and somewhat paradoxical use of a *Java applet* to accommodate a pure *Java CORBA ORB* front-end in order to communicate via *HTTP*-tunnelled *IIOP* with a *DCOM/MTS* back-end through a *CORBA/COM* bridge. The rationale for this arrangement would be that the *Java ORB* may be downloaded and work properly in both *Netscape* and *Internet Explorer* on any client machine, whereas an *ActiveX control* communicating via *(HTTP*-tunnelled) *DCOM* – or some other protocol – would not.

2533 See [Micr98η-θ], [Verb99a-b], [Wats99], [Chap96b] p. 301 et seqq., and [Sess98a] p. 101 et seqq. The *Microsoft VM* is part of the *Microsoft SDK for Java.*

2534 *IUnknown, IDispatch, IDispatchEx, IProvideClassInfo, IProvideClassInfo2, ISupportErrorInfo, IMarshal, IConnectionPointContainer,* and *IExternalConnection* are always supported. For *Java* objects that implement *java.io.Serializable, java.io.Externalizable,* or *com.ws.wfc.core.IComponent,* support for *IPersist, IPersistStreamInit,* and *IPersistStorage* will be provided as well. If a *Java* object is registered as a *COM* object supporting the *(ActiveX) Control* category*,* yet another set of interfaces will be supplied, including *IOleControl, IOleObject, IOleWindow, IOleInPlaceObject, IOleInPlaceActiveObject, IPerPropertyBrowsing, IViewObject,* and *IViewObject2*. For some controls, *IObjectSafety* and/or *IDataObject* will also be implemented. For more details, see [Verb99a].

2535 For a *Java* class or a *Java Bean* to become accessible to *COM* clients, the *javareg* utility must first be used to create a type library for it and to register it with the *Windows* registry. *JavaBeans* are by default exposed as *ActiveX* controls, which provide the same methods, properties, and events as the bean. It should be noted that the *Microsoft VM* acts as a bridge between *Java* and *COM* and, hence, will have to be loaded together with the hybrid *Java Bean/ActiveX* control. A *Java Bean* may be used in *Internet Explorer* (through the *OBJECT* tag) without the previous use of *javareg.*

On the other hand, a programmer may choose to import existing *COM* objects into *Visual J++* by using the *jactivex* tool, which will emit the corresponding *Java* source code class wrappers – referred to as *Java-Callable Wrappers (JCWs)* – and packages by examining either the *DLL* containing the *COM* objects or the type libraries of the *COM* objects.[2536] Similarly, an *ActiveX* control may be converted into a *Java Bean,* to which will be automatically attached *JavaBeans* methods for adding and removing *event listeners*. The use of *Java* for handling *COM* objects provides some exhilarating benefits. Firstly, the programmer will be relieved of the drudgery of reference counting, as *Java* may be relied upon for garbage collection.[2537] Secondly, the need to call *IUnknown::QueryInterface* in order to acquire a pointer to an interface will disappear – this will be done by the *Microsoft VM* under the hood. In addition, the class libraries that come with *Visual J++* encapsulate much of the *COM* functionality in a less unprepossessing guise than that of the raw *COM* interfaces. The *Windows Foundation Classes (WFC)* framework of *Visual J++ 6.0* also includes classes, which make for easy access and manipulation of the *Dynamic HTML* object model of a web page.[2538]

Since *Microsoft's VM* is implemented as an *ActiveX* control, a *Java* applet may be loaded and run in any *ActiveX* container, not only *Internet Explorer*. In addition, as an *ActiveX* control may be scripted, the public members of an *applet* may be accessed from scripts, from other *applets,* or from *ActiveX* controls on the same web page. Although the functionality of *applets* usually is seriously curbed by the security restrictions of the *sandbox,* an *applet* carrying the cachet of a digital signature will become trusted to invoke the system *APIs* and the methods of other *COM* objects.

1.2.23.6 ActiveX Hyperlinks, the Active Desktop, and Active Channels

There are two distinct tropisms within the grand unification of the *GUI* and *WUI* currently attempted by *Microsoft:* On the one hand, the *WUI* of the web browser rapidly moves closer to the level of sophistication attained by ordinary *GUI* applications long since. On the other hand, web content and *WUI* features such as hyperlinks have seeped into *GUI* applications as well as the *Windows* shell, including both the *Windows* desktop and the *Windows Explorer* file system browser. In this section, we will have a look at the latter tropism, from the *WUI* to the *GUI*.

The *OLE (Object Linking and Embedding)* and *Active Documents* technologies make it possible for a container application to host a free-standing web browser capable of acting as an *OLE* or *Active Documents* server. For closer integration and detailed programmatic control, the *WebBrowser* or *MSHTML ActiveX* controls may be utilised instead. Another amenity useful for imbuing *Windows* and *Windows* applications with web awareness is provided by the *ActiveX Hyperlinks* technology, which is part of *Microsoft's Internet Client SDK.*[2539] *ActiveX Hyperlinks* may be taken advantage of in order to bring *hyperlink navigation* to ordinary applications, components, and documents – including well-known browsing features, such as history and favourite lists, and the go back/forward/home commands. *Microsoft* has implemented support for *ActiveX Hyperlinks* in its *Office* suite, thereby bestowing hypertextual capabilities upon plain *Word* and *Excel* documents.

The *ActiveX Hyperlinks* architecture involves rather complex interactions between a number of *COM* building blocks:

2536 Because of the limitations of the type system of *Java,* which, for instance, does not support pointers, the importation of *COM* objects is essentially restricted to *automation objects* and *ActiveX* controls. In order to support non-*Automation* compatible types, *custom marshalling* may occasionally be resorted to. See [Micr98η].

2537 There is an option to explicitly release a *COM* object through the *ComLib.release* method. Unfortunately, explicit release is currently the recommended course, because the "threading limitations of many *COM* objects" may mess up the garbage collection mechanism of *Java.* See [Micr98η].

2538 [Micr98ϵ-ζ]. *WFC* also supports *Win32 GUI* programming fully, thereby rendering *Microsoft's* other *Java GUI* framework, *AFC (Application Framework Classes),* more or less obsolete. *WFC* may be regarded as *Microsoft's Windows*-centric alternative to the putatively portable *Java Foundation Classes (JFC).*

2539 See [Micr98ι] and [Chap96b] p. 305 et seqq.

- a *hyperlink object* implements the *IHlink COM* interface and is created and used for navigational purposes by a *hyperlink container*
- a *hyperlink container* is a document or application capable of containing *hyperlinks* by virtue of its support for the *hyperlink site* and, optionally, *hyperlink target* interfaces
- a *hyperlink site* implementing *IHlinkSite* is the part of a *hyperlink container* used by *hyperlink objects* for communicating with their container
- a *hyperlink target* is a *COM* object that implements the *IHlinkTarget* interface, thereby enabling *hyperlink objects* to interoperate with the target so that they may navigate to a position inside the target and will be able to provide support for the *hyperlink browse context*[2540]
- a *hyperlink frame* is a browser application such as *Internet Explorer* or the *Office Binder,* supplying a common frame window for browsing different document types[2541]
- a *hyperlink browse context* – implementing *IHlinkBrowseContext* – maintains the *navigation stack* for the different kinds of documents and supports the *go back/go forward* browsing commands

Hyperlinking involves a jump from a *hyperlink container* to a *hyperlink target.* This transition may cause a new application to be launched and the control and focus to be transferred to the main window of this application. If both container and target are *Active Document* objects[2542] and the source application is an *Active Document* container as well as a *hyperlink frame,* the target document will, however, be displayed inside the same frame as the source document.

The *hyperlink object* is a *COM* object implementing the *IHlink* interface and holds four different pieces of information:

- a moniker that identifies the target of the hyperlink
- a string indicating a position within the target
- a user-friendly name
- a string of parameters

The above pieces of data are given as arguments, when, in response to a user's clicking on a link, a *hyperlink object* is created by the *hyperlink container* through either of the *HlinkCreateFromMoniker, HlinkCreateFromString,* or *HlinkCreateFromData* functions. Upon creation of the *hyperlink object,* the container will call its *IHlink::Navigate* method in order to cause the hyperlink to navigate to its target, which, as we just pointed out, may imply that another application will have to be started.[2543] There is also a *simple hyperlinking API* consisting of four helper functions, which in many cases may be more versatile to use for plain navigation and go back/forward functionality than the full *ActiveX Hyperlinks* architecture.[2544]

[2540] A target does not need to implement *IHlinkTarget,* but if it does not, it will not be able to support internal navigation and the navigation stack maintained by the *browse context.* A full-fledged target should implement both the *Active Documents* and the *hyperlink target* interfaces. *Hyperlink containers* need to be *hyperlink targets* as well in order to support links to locations inside the current document.

[2541] Preferably, the *hyperlink frame* should be an *Active Document container.*

[2542] Documents that are not *Active Documents* are sometimes referred to as *top-level documents.*

[2543] The nitty-gritty details are as follows. First, *IHlink::Navigate* retrieves the moniker of the container from the *hyperlink site.* The *hyperlink object* then compares this moniker with its own and, in case the two are identical (i.e. the link clicked on was internal), it also retrieves the *IHlinkTarget* interface of the container from the *hyperlink site.* If the monikers are different, it calls the *BindToObject* method of its own moniker instead, which will open the document linked to, as soon as the appropriate application has been activated (if it is not already running). The *IHlink::Navigate* will then request the *IHlinkTarget* of the target object. Regardless of whether the hyperlink referred to a location in the current or in an external document, *IHlinkTarget::Navigate* will now be called in order to navigate to the correct position inside the target document. If no position has been specified or the target document does not support *IHlinkTarget,* this last step will, of course, be skipped.

[2544] These functions are *HlinkSimpleNavigateToString, HlinkSimpleNavigateToMoniker, HlinkGoBack,* and *HlinkGoForward.*

The *Active Desktop* is another keystone of *Microsoft's* efforts to weld the *Windows* shell and the web together.[2545] The simple, but serendipitous idea of using the *Web Browser control* as the *Windows* background, thereby providing an omnipresent *Active Document container* capable of hosting all kinds of *Active Documents,* forms the foundation of the *Active Desktop* technology. The *Active Desktop* encompasses two distinct layers: The *HTML layer,* which is an *Active Document container* acting as a wallpaper background, and the *icon layer* on top of this. The *HTML* layer may host various kinds of *Active Desktop items,* including *ActiveX* controls, images, *HTML* documents, etc. Popular categories of *Active Desktop items* include news, weather, and stock tickers. These will float above the wallpaper background, but will always display underneath the *icon layer.* The *IActiveDesktop* interface exposed by the *Active Desktop COM* object, which is part of the *Windows Shell API,* makes it possible to programmatically inspect, add, remove, and modify the *Active Desktop items* and control various other aspects of the *Active Desktop.*[2546] The *icons layer* has also been modified so as to conform better with the browsing metaphor, e.g. through the support of single-click activation/navigation. Finally, an *Internet Shortcuts API* has been added, which may be used in the *icon layer* of the desktop – or inside applications – to create shortcuts to *URLs.*[2547]

Internet Explorer also supports various aspects of *webcasting,* which in *Windows* are implemented by the *Information Delivery API.*[2548] For one thing, it allows the user to *subscribe* for any web page, which is to say that *Internet Explorer* will cache the page, check for changes at regular intervals, and automatically download changed pages to the cache. Cached documents do not only load faster than non-cached ones, but will be available for *offline browsing* as well. This kind of subscription support is sometimes referred to as *basic webcasting.* A web master may provide defaults for the various subscription options (such as the download intervals) through a *Channel Definition Format (CDF)* file, thereby creating an *Active Channel.* This variety of *webcasting* is known as *managed webcasting* or *"smart" pull.*[2549] *Multicasting,* also known as *"true" webcasting* or *"true" push,* is a third kind of *webcasting,* which by means of special network hardware and protocols lets a server control the distribution of data to multiple clients within a corporate network. It is possible to combine *Internet Explorer* with "push" products – such functionality is currently supported by the *Windows Media Player.* The advent of *WebTV* may give momentum to *push technology* as well as expand its reach to public networks, i.e. transform *multicasting* into *broadcasting.*[2550] The rise of push technology seems to indicate that the convergence of the computer industry, the broadcast and motion picture industry, and the print and publishing industry predicted by Nicholas Negroponte since the late 70s now actually is imminent.[2551]

1.2.24 DYNAMIC HTML

Dynamic HTML (DHTML) is pivotal in *Microsoft's* user interface strategy, and it is *DHTML* that *Microsoft* would like to see as the foundation of a future unified web and PC user interface.[2552] The overriding objectives of *DHTML* is to enrich the user interface, increase "dynamic" interactivity, and reduce costly downloads and net roundtrips by extending and refining *HTML* in various ways, thereby staving off the need for the essentially rather kludgy use of adscititious technologies, such as *Java* applets or *ActiveX* controls, on web pages.[2553]

[2545] [WE97]. [Edwa98c] discusses the modifications of the *Active Desktop* expected in *Internet Explorer 5.0.*

[2546] The *IShellUIHelper* interface/object provides partly overlapping functionality.

[2547] [Hess96]

[2548] See [WE97] and [Micr97m].

[2549] *CDF* is an application of *XML.* A *CDF* file may also be used to specify an *Active Desktop item* or an *Active Screen Saver,* to create a hierarchical description of a web site, to define various options with reference to logging, user authentication, and suchlike. It is also possible to combine *CDF* and *OSD (Open Software Description)* in order to define a *Software Distribution Channel* for the delivery of software updates. The *Channel Bar* of *Internet Explorer 4.0* is an *Active Desktop item* holding an array of shortcut icons to the *Active Channels* a user subscribes to. Reportedly, it will be discontinued in *Internet Explorer 5.0.*

[2550] Abundant information on *WebTV* is available at http://developer.webtv.net/Default.htm.

[2551] See [Bran87] p. 10 et seqq. Cf. also [Negr96].

[2552] [Micr97i] and [Micr97n] provide short overviews of *Microsoft's Dynamic HTML,* [Isaa97] a comprehensive treatment.

[2553] [MFDG98] p. 60 contains a list of problems of *HTML.* These include want of link tracking, loose syntax checking, no extensibility, little support for rich structures such as nested hierarchies, no content-awareness, lacking or inconsistent support for international and special characters, no support for semantically tagged data exchange, no dynamic content without server roundtrips or applet programming, and very little support for object-oriented concepts. Many of these problems are addressed by *Dynamic HTML,* others by *XML.*

It should be noted that for the nonce the term *Dynamic HTML* is not as distinct a concept as, for example, *HTML* or *XML,* of which there are well-defined, version-numbered descriptions recommended by the *World Wide Web Consortium (W3C).*[2554] On the contrary, *Dynamic HTML* comprises a miscellany of different technologies, and there are currently two divergent and largely incompatible dialects of it, the one defined by *Microsoft's Internet Explorer,* the other by *Netscape's Navigator.*[2555] *Netscape,* being deeply entrenched in the *Java* camp, has been markedly reluctant to introduce any new technology that has the potential to erode the need for *Java* applets.[2556] In contrast, the elimination of applets from web pages is an overarching goal of *Microsoft's Dynamic HTML,* and *Microsoft* itself has tried to set an example by replacing all *Java* applets in its own web pages with *DHTML*-based functionality.[2557] Consequently, *Microsoft's* variant of *Dynamic HTML* is much more far-reaching and ambitious in scope than *Netscape's.* One may deplore the division of the web emanating from such diversity in outlook, but such is the price to be paid for pluralism – as long as *Netscape* dominated the web browser market, *de facto*-standards were set by *Netscape's* implementing support for a feature. Today, neither *Netscape,* nor *Microsoft* is in the position to dictate standards in this way, and, in spite of the work of standardisation bodies such as the *W3C* and the *IETF (Internet Engineering Task Force),* we probably have to accept that the web will bifurcate into two distinct dialects with a least common denominator that grows only tardily.

What are the amenities supported in *Microsoft's Dynamic HTML?* The current state of *Dynamic HTML* is defined by the features supported in *Internet Explorer 4.01,* although various enhancements have been announced for *Internet Explorer 5.0* and are available in the 5.0 beta version.[2558] A number of recent *W3C* standards may be regarded as providing the foundation of *Dynamic HTML:*[2559]

- *HTML (Hypertext Markup Language) 4.0*[2560] is the latest version of the well-known language for web page definition.
- *CSS (Cascading Style Sheets)*[2561] is a language for the definition of *style sheets.* A *style sheet* is a combination of various presentation style attributes, such as fount family and size, text alignment, and background and text colour. It may be defined *inline* to modify a single *HTML* element or separately from the content and structure of a document, either in the head of the document *(global style sheet)* or in a separate file *(linked style sheet).* A *global style sheet* may be applied to multiple *HTML* elements within a single web page by the use of *custom tags,* whereas a *linked style sheet* may be used in multiple pages. Furthermore, many styles may be *cascaded* onto the same element in a well-specified *cascading order.*
- The *Document Object Model (DOM)*[2562] is an *API* that makes every element of an *HTML* (or *XML)* document accessible to scripts or programmes. All web page content and *HTML* elements (including tags, attributes, etc.) on a page may be inspected, modified, and deleted, new elements may be added, and documents may be navigated and built programmatically. Although *Internet Explorer* does not currently support the interfaces of the *W3C DOM API,*

[2554] [Ragg97] is the specification of *HTML 3.2,* [RLJ98] that of *HTML 4.0,* and [BPS98] that of *XML 1.0. W3C* has issued recommendations for some of the vital parts of *Dynamic HTML* recently and is currently in the process of doing so for others as well, although these specifications are not as yet strictly adhered to in browser implementations.

[2555] [Micr97j-k] compare these. Cf. also [MFDG98].

[2556] [Matt99] reports that *Netscape Navigator 5.0,* scheduled for release in late 1999, will provide better support for the *W3C DHTML* (and *XML)* recommendations, including *Cascading Style Sheets* (both level 1 and 2) and the *Document Object Model.*

[2557] Cf. [WM98], which also provides some statistics on the reduction in load/initialisation time and file size when going from *Java* applets to *Dynamic HTML.*

[2558] See [Micr98p] and [Micr98u].

[2559] Although some *Microsoft* documents discuss *Dynamic HTML, HTML,* and *Cascading Style Sheets (CSS)* as if they were three distinct technologies, most authors seem to understand *CSS* and *HTML 4.0* as subsumed under *Dynamic HTML* – as are scripting and *DHTML scriptlets,* besides. In contrast, *XML* is not part of *Dynamic HTML,* although it is supported by *Internet Explorer.*

[2560] See [RLJ98] and [MK98].

[2561] [LB96] is the *Level 1* specification, [BLLJ98] the *Level 2* one. *Level 2* is only partially supported in *Internet Explorer 4.0.* Full support is expected in *Internet Explorer 5.0.*

[2562] [ABCI+98]. Some *Microsoft* documents use the term *Dynamic HTML Object Model* synonymously with *Document Object Model.*

it implements the same kind of functionality, and its object model is, according to *Microsoft,* essentially consistent with that of *W3C.*[2563]

The *Document Object Model* is the kingpin of *Microsoft's Dynamic HTML.* The web page document and its elements are navigated through the *Internet Explorer* object model, which is a hierarchy of objects largely, but not entirely, compatible with that of *Netscape Navigator.* At the root of this hierarchy is the *window* object, which contains, among other items[2564], a *document* object holding the contents of the web page in a number of aggregated objects and collections of objects.[2565]

With every element of a web page are associated *properties, methods,* and *events* – *Microsoft's Document Object Model* goes beyond the current *W3C DOM* by its support for *events,* although *events* are supposed to be added to the *W3C DOM* later.[2566] Standard mouse, drag and drop, keyboard, selection, scroll, focus, and help events are supported as well as various browser specific events, and *event bubbling* makes each event propagate from the specific element, in which it originated, through the document hierarchy up to the *document* object and its parent *window* object at the root of the hierarchy. At each level, the event may be processed, either through a *default action* defined by the browser or by a custom event handler, i.e. a script, which has been associated with the event through *event binding.* A custom event handler may either override or augment the *default action,* and it may also choose to cancel the *event bubbling.* There are a number of different ways to do *event binding;* one is to dynamically assign a pointer referencing the event handler script to an object property that represents the event to be handled. Incidentally, properties and methods (i.e. function pointers) may also be added to an object dynamically.

Events and scripts are crucial to swift user interaction and, alas, may also be used to achieve multimedia and animation effects. In addition, multimedia effects may be brought about by *visual filters* and *transitions*. Whereas the former modify the appearance of an element in some way or other – e.g. by making elements transparent, radiant, inverted, shadowed, wavy, etc. –, the latter are taken advantage of in order to make such filtering vary over time.[2567]

The support for *DOM, CSS,* and scripting in *Dynamic HTML* makes it possible to support features, such as:

- *Dynamic styles*. One may change style sheets as well as individual properties of web page elements at run-time without having to reload the page from the server.
- *Dynamic content.* It is possible to access and modify the contents of a web page dynamically without server interaction.
- *Dynamic positioning. Static, relative,* and *absolute* positioning is supported by *CSS (level2)*, and positioning may be done dynamically during execution.[2568]

These particulars will be conducive to a full-blown and responsive web user interface, as will other *DHTML* features, such as support for fount embedding in web pages and automatic fount download.

Another important element of *Dynamic HTML* is *data binding,* which is a mechanism for binding single-valued or tabular *data consumers* on a web page – *HTML* elements, *Java* applets, or *ActiveX* controls – to a *data provider,* such as a relational database or a file, through the intermediation of a *data source object (DSO),* i.e. an *ActiveX* control or *Java* applet residing on the same web page as the consumer and providing access to data

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[2563] [Micr98q]

[2564] The other items are *event, frames, location, history, navigator* (alias *clientInformation),* and *screen.* For a discussion of these, see [Isaa97] p. 32 et seqq.

[2565] These are *anchors, links, applets, forms, frames, images, scripts, styleSheets, body, selection,* and *all.*

[2566] See [W3C98]

[2567] *DirectAnimation, LiquidMotion,* and the recently demised *Chromeffects* are other *Microsoft* technologies for creating multimedia and animation effects on web pages.

[2568] *Static positioning* is the default *HTML* positioning mechanism, providing the page designer with only limited control, whereas *absolute* and *relative positioning* are used to assign a fixed and a relative position, respectively, to an element.

from the *data provider* through the *OLE DB* or the *OLE DB Simple Provider API.*[2569] A *binding agent* and a *table repetition agent* transparently manage the connections and the synchronisation between *data consumers* and *DSOs* by, for example, feeding new data to *data consumers* and updates back to the *DSOs*. Together with *Internet Explorer, Microsoft* ships a few *DSOs,* including a simple *Tabular Data Control (TDC),* the *Remote Data Service (RDS) ActiveX* control*,* an *XML DSO,* of which there is both an applet and an *ActiveX* control variant, and a *JDBC* applet *DSO,* and it is also possible to create custom *DSOs.*[2570] *DSOs* support a *recordset* property that makes it possible to access the *DSO* as an *ADO Recordset* object, which may be manipulated in a number of interesting ways.[2571] In particular, *recordset* access will often come in handy in scripts. In addition to the *DSOs* mentioned, *Internet Explorer* internally implements the *MSHTML Data Source,* which exposes the *HTML* contents of any web page – client-based or server-based – as a read-only *ADO recordset*. By the same token, *Internet Explorer 5* will make use of a much enhanced C++-based *XML DSO* in order to expose any *XML* content on a web page as an *ADO recordset.*[2572]

Additionally, *Microsoft* has integrated support for *DHTML* in their *Visual* tool suite. For instance, *Visual J++ 6.0* and *Visual Basic 6.0* both come with integrated *DHTML* web page editors, and both the *WFC Java* framework and the *MFC C++* framework now support programmatic access and manipulation of the *DHTML* object model.[2573] For serious script-based web authoring, *Visual InterDev* will be *Microsoft's DHTML* tool of choice, providing support also for easy integration with databases and the *Microsoft Transaction Server*. Finally, *MSHTML* or the *DHTML Editing Component DocObject* and *ActiveX Control* may be used to include more or less sophisticated *DHTML* editing capabilities in any application or web page.[2574]

1.2.24.1 Dynamic HTML Scriptlets

Microsoft's first attempt at a component-based beachhead on the *Internet* involved the use of *ActiveX* controls on web pages. This approach did not gain widespread popularity for three simple reasons: It was not portable enough, it was not safe enough, and it was not directly supported by *Netscape Navigator.*[2575] The lack of portability explains itself from the binary character of *ActiveX* controls, as do the safety concerns. As explained above, *ActiveX* binaries do not lend themselves to the *sandboxing* security techniques used in *Java* applets, but rely upon the somewhat less safe method of *trust verification.*[2576] Still, *ActiveX* controls are widely used as the *Internet Explorer* equivalent of *Netscape's* plug-ins in order to add support for new facilities – such as the display of new media or data types – from trusted sources. *ActiveX* controls may also be very useful when building *intranet* solutions, since they let the programmer leverage the operating system facilities fully. Whereas the want of support for *Microsoft* technologies in *Netscape Navigator* is a problem *Microsoft* cannot do much about, the other two issues were attended to in *Internet Explorer 4.0* by the introduction of script-based components, which may be reused in the same manner as *ActiveX* controls without being liable to their safety and portability problems.

A *Dynamic HTML (DHTML) scriptlet* is a *Dynamic HTML* web page (i.e. an .htm file) packaged as a special kind of *COM* object, which may be used inside another web page through the *OBJECT* tag.[2577] Just as an *ActiveX* control, the *DHTML scriptlet* supports *methods, properties,* and *events,* and it is also possible to outfit it with a *context menu* that will show up when right-clicking the mouse. *Methods* and *properties* are declared by the

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2569 See [Micr99b].

2570 See ibid., [Isaa97] p. 413 et seqq., and [SH98] p. 172 et seqq.

2571 Cf. infra p. 614.

2572 Cf. infra p. 570

2573 See [Micr98ε-ζ] and [Micr98μ]. Cf. also [Gros98].

2574 [Micr99c-d]

2575 However, the *scriptactive* plug-in from *NCompass Labs* adds support for *ActiveX* controls to *Netscape Navigator*.

2576 [Chap96b] p. 299 et seqq.

2577 See [Jerv97], [Edwa98a], [Espo98], and [Micr98s]. *DHTML scriptlets* were originally referred to as just *scriptlets*. This term should now, however, only be used to signify *XML scriptlets*. An *OBJECT* tag for a *DHTML scriptlet* may look like this:

```
<OBJECT ID="DHTMLSimplet" TYPE="text/x-scriptlet" DATA="http://www.dna.lth.se/erikp/dhtml.htm">
```

observation of a simple name convention – variables and functions starting with the prefix *public_* automatically become *properties* and *methods*. It should be noted that this prefix is removed from the name exposed to clients of the scriptlet. Alternatively, properties and methods may be defined in a special *JScript* object *public_description,* in which case the name convention is overruled. As for *events,* the scriptlet may propagate – or "bubble" in the lingo of *DHTML* – standard window events from its own *HTML* elements to the container by catching the event in a handler and forward it by calling the *bubbleEvent* method. Additionally, it may throw *custom events* by calling a *raiseEvent* method, which will cause the special catch-all *onscriptletevent* to fire. This event has two arguments, viz. a string specifying the name of the event and an arbitrary object that is used to pass additional data as needed.

It will be possible to use *DHTML scriptlets* in any *ActiveX* container, such as a *Visual Basic* form or a *Word* document, as a *DHTML scriptlet* accommodates the *MSHTML* rendering engine so as to be able to display itself. When the *DHTML scriptlet* executes inside such an *ActiveX* container, a "bridge layer" referred to as the *scriptlet container object* negotiates screen estate and passes method calls and property access requests into the scriptlet as well as events out of it. In case the *DHTML scriptlet* is inserted in a secure container such as *Internet Explorer,* it will adopt the security policy of the container. Thus, the security problems of ordinary *ActiveX* controls are not incident to a *DHTML scriptlet.* It is possible to use a *DHTML scriptlet* on any platform, where *Internet Explorer* is available, although *Netscape Navigator* does not support scriptlets.

The *DHTML scriptlet* technology is, however, already approaching obsolescence.[2578] In *Internet Explorer 5.0, DHTML Behaviors,* a new technology for the componentisation of scripts, will be introduced. In the beta 1 version of *Internet Explorer 5.0, behaviors* were implemented through *scriptlets* – also referred to as *XML scriptlets* – another new *Microsoft* technology for script components, not to be confused with *DHTML scriptlets*. In the beta 2, an even newer technology, *HTML components (HTC),* has already replaced the *XML scriptlets*.

1.2.24.2 DHTML Behaviors

The *DHTML Behaviors* technology has been advertised as a major enhancement to be introduced in *Internet Explorer 5.0.*[2579] Just like *Cascading Style Sheets* made the separation of layout from content possible, *DHTML Behaviors* will facilitate the isolation of behaviour from content. Hence, content authors will be able to work independently both of the designers of styles and effects and of the engineers who implement these effects. Additionally, *Behaviors* will make it possible to cleanse web pages from the script code frequently clogging them up.

Behaviors may be associated with a *CSS* style definition or be applied directly to a particular *HTML* element. In either case, the *Behavior* will be specified by the new *CSS* attribute *behavior.*[2580] A *CSS* style may be assigned to a *custom tag,* which may then be used as any *HTML* tag. Finally, *behaviors* may be added and removed dynamically through two new methods, *addBehavior* and *removeBehavior.*

Just like *DHTML scriptlets, behaviors* expose methods and properties and may fire events, although they do not contain any *HTML* or other visual elements. A *behavior* may be implemented by a script component (an *XML scriptlet* in the beta 1 of *Internet Explorer 5.0,* an *HTML Component* in the beta 2), by a binary component, such as an *ActiveX* control or a *Java* applet[2581], or by a *default behavior* provided by *Internet Explorer*. We will now

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[2578] [Clin98] points out some weak spots of *DHTML scriptlets:* Firstly, since each *scriptlet* encapsulates its own instance of *MSHTML*, *scriptlets* may incur considerable overhead in terms of memory requirements and loading time, particularly in case the *scriptlet* is used inside a container other than *MSHTML*. Secondly, *scriptlets* are not real *COM* objects and, consequently, may be awkward to use outside *HTML* pages – they can, for one thing, not be registered in the *Windows* registry. Thirdly, the use of a naming convention to declare public members will be problematic and arbitrary. Somewhat oddly, these grievances look like a list of disincentives against using *JavaBeans* as well, which, for example, need *JVM* to execute and rely on a similar naming convention scheme as *DHTML scriptlets*. *XML scriptlets* have been designed to be impervious to these problems.

[2579] See [Micr98t]. *Netscape* has submitted *Action Sheets,* a rivalling technology for defining behaviour for *XML* and *HTML* elements, to *W3C*. See [AEGR98].

[2580] Typically, by an incantation styled in this way: `behavior:url(simplet.htc)`

[2581] The binary component must be declared in an *OBJECT* tag in order to be referred to in the *CSS behavior* attribute.

discuss the two kinds of script component technologies that have been used to implement *behaviors, XML scriptlets,* and *HTML Components (HTCs).*

1.2.24.3 XML Scriptlets

XML scriptlets, or simply *scriptlets,* are *COM* components packaged as *.sct* text files that encapsulate scripts written in any scripting language that supports *ActiveX Scripting,* such as *Microsoft's* own *Visual Basic Scripting Edition (VBScript)* or its *ECMA-262* compatible *JavaScript* variant *JScript.*[2582] *Scriptlets* generalise the *DHTML scriptlet* technology by directly supporting important *COM* interfaces, such as those pertaining to *Automation*[2583], events,[2584] or *DHTML Behaviors.* Similarly to *DHTML scriptlets, XML scriptlets* expose methods, properties, and events. In contrast to *DHTML scriptlets, XML scriptlets,* however, lack a user interface. Hence, a *scriptlet* will be useful not only as client side components, but may be used in any component container capable of handling the type of component impersonated by the *scriptlet* (typically an *automation object).* Possible middle-tier containers include the *Microsoft Transaction Server (MTS)* and the *Actives Server Pages (ASPs)* of the *Internet Information Server (IIS),* whereas *Visual Basic, Internet Explorer, Microsoft Windows Scripting Host (WSH),* and many other *ActiveX* containers may be used on the client side. *Scriptlets* may be inserted on an *HTML* web page through an *OBJECT* tag or (in *Internet Explorer 5* beta 1) through the *CSS behavior* attribute. In a programme written in, for example, *Visual Basic* a scriptlet may instead be created dynamically.[2585]

In contrast to *DHTML scriptlets, XML scriptlets* do not need a *scriptlet container object* to support common *COM* interfaces, as they make use of precompiled *interface handlers.* The most frequently used of these – such as the *Automation* and *Event* handlers – are built into the *scriptlet run-time* SCROBJ.DLL, which is a *COM in-process server.* Other interface handlers may be added as separate components or be included in the run-time of a container application. The beta 1 of *Internet Explorer 5.0,* for instance, included an *interface handler* for *DHTML Behaviors,* which, by the way, also ensured that the security restrictions of the web browser were observed by the *scriptlet.*

The intricacies of *COM* are almost entirely concealed from the *scriptlet* programmer, who, in addition to the script code implementing the behaviour of the component, must enter a few *XML* tags in the *.sct* script file in order to specify which *interface handlers* are to be used, to define the methods, properties, and events exposed by the *scriptlet*, and, optionally, to add *COM* registration information for the *Windows* registry (class id, programme id, etc.). *Events* may be fired from the scripts in the *scriptlet* by the *fireEvent* method of the event handler object, and properties may be specified either as simple values or by put/get functions. An elemental *scriptlet* may look like this:[2586]

[2582] See [Micr98s]. [Espo98] and [Clin98] contrast the *XML* and *DHTML scriptlet* technologies. The term *scriptlet* is currently preferred in *Microsoft* documents, although for the sake of clarity *XML scriptlet* is occasionally used as well.

[2583] *IDispatchEx.*

[2584] *IConnectionPoint* and *IConnectionPointContainer.*

[2585] The *Visual Basic* code for this would be:

```
Set scriptlet = CreateObject("Simplet.Scriptlet")
```

[2586] The <registration> tag contains the class and programme id, a version number, and a textual description, whereas the *interface handler* (type) and its internal name (id) are specified in the <implements> tag. The rest should be self-explanatory.

```
<scriptlet>
   <registration Description="Simplet" ProgID="Simplet.Scriptlet"
      ClassID="{C37E8E40-8214-11d2-BCF5-A67F20000000}" Version="0.99"/>
   <implements type="Automation" id="automation">
      <method name="Test" />
      <property name="val" />
   </implements>
   <implements type="Event" id="thisScriptlet">
     <event name="testHappened"/>
   </implements>
   <script language="JScript">
      var val;
      function Test() {
         eventObject=createEventObject();
         eventObject.result=val++;
         thisScriptlet.fireEvent("testHappened",eventObject);
         return val;
      }
   </script>
</scriptlet>
```

By using the *attachEvent* method of the *Internet Explorer 5.0* object model, the scriptlet may subscribe for notifications of events occurring on the embedding web page and specify an event handler to be called upon arrival of the notification. Additionally, the *scriptlet* run-time may generate a type library, which will be needed by some containers, such as *Visual Basic,* in order to support events and other functionality. A *scriptlet wizard* may be taken advantage of in order to generate a template for a *scriptlet,* and there are also various debugging facilities.

1.2.24.4 HTML Components

An *HTML Component (HTC)* is a lightweight script component supporting the same kind of functionality as a *scriptlet.*[2587] Just like a *scriptlet,* it may be written in any language that is implemented with the *ActiveX Scripting* interfaces, and it exposes its methods, properties, and events in a manner similar to a *scriptlet.* In the same way as a *scriptlet,* it may access the web page *element* to which it is attached and its object model (properties, methods, and events), and it may subscribe for notifications of *Dynamic HTML* events and the two special events *oncontentchange* and *ondocumentready.* It uses *XML* tags to define its methods, properties, and events, as well as to *attach* handlers to events.

The *XML* syntax used in *HTML Components* is, however, entirely different from that used in *scriptlets,* and unlike a *scriptlet,* an *HTC* does not support any *COM* interfaces. Consequently, an *HTC* may only be used on web pages displayed in *Internet Explorer 5.0* – currently no announcement exists for a *COM* adapter similar to the *scriptlet container object* used to cater for the *ActiveX* capabilities of *DHTML scriptlets.* At this writing, *Microsoft* has not – in our ken at least – published any explanation as to why the shift from the widely applicable *COM*-based *scriptlet* technology to the much less general *HTCs* was made. However, *Microsoft* has submitted the *HTC* technology to *W3C* for consideration.[2588]

Below is given the code of a small *HTC,* which implements the same methods, properties, and events as the “Simplet” *XML scriptlet* given as an example above. The *URN* parameter of the *PUBLIC:HTC* tag should identify the *HTC* uniquely:

[2587] [Micr98v]

[2588] [Wils98]

```
<PUBLIC:HTC URN="www.dna.lth.se/erikp/htcsimplet.htc">
   <PUBLIC:METHOD NAME="Test" />
   <PUBLIC:PROPERTY NAME="val" />
   <PUBLIC:EVENT NAME="testHappened" ID="testHappenedEvent" />
   <SCRIPT LANGUAGE="JScript">
      var val;
      function Test() {
         eventObject=createEventObject();
         eventObject.result=val++;
         testHappenedEvent.fire(eventObject);
         return val;
      }
   </SCRIPT>
</PUBLIC:HTC>
```

The *HTC* is associated to a style or an *HTML* element through the *CSS behavior* attribute as described above.

Making the choice between all these species of components – *Java applets, JavaBeans, ActiveX Controls, DHTML scriptlets, XML scriptlets, HTCs* – will call for circumspection. If maximum portability and native support by *Netscape Navigator* are required, the *Java* technologies will provide the only alternative, although performance and the degree of finesse of the user interface may suffer, if the *Java* road is taken. If *Internet Explorer* only is targeted, script components may be an attractive choice – among the available variants, *DHTML scriptlets* will probably be ousted by *behaviors* implemented as *HTCs,* whereas the future rôle of the *XML scriptlet* technology currently is somewhat nebulous. Finally, at the expense of some security and portability, *ActiveX Controls* provide the developer with the freedom of doing any kind of systems programming needed.[2589]

1.2.25 FUTURE DEVELOPMENTS

Dynamic HTML is currently in a process of intense development. The next version of *Microsoft's* web browser, *Internet Explorer 5.0,* will – aside from better performance, better conformance with *W3C* specifications, and the like – implement a large number of new *DHTML* features.[2590] These will include *behaviors* as described above and various *GUI* enhancements, which will make it practical to provide web pages that better conform with what users expect from their experience of ordinary *GUI* applications. For instance, there will be enhanced support for and control of data transfer (cut, copy, and paste as well as drag and drop), mouse handling, positioning, table layout, and scrolling. It will also be possible to do simple vector graphics through a *Vector Markup Language (VML).*

Two other new *Explorer 5.0* technologies making for the unification of the traditional *GUI* and the web user interface are *Web Folder Behaviors* and *HTML Applications. Web Folder Behaviors* will make it possible to browse an *HTTP* server and its resources through folders in a way similar to a file system. *HTML Applications (HTAs)* are *Dynamic HTML* pages – saved with the extension .hta – that are executed as independent, fully trusted applications, forsaking the menus and toolbars of *Internet Explorer* as well as its security restrictions.[2591]

These developments are important steps towards *Forms+,* the technology supposed to ultimately amalgamate the *Win32* desktop and the web user interfaces.[2592] This is, however, not expected to happen until some time well after the introduction of *Windows 2000* (previously known as *Windows NT 5.0),* which is expected to be released no earlier than in late 1999 and possibly later.

[2589] [Winn98a], [WM98], and [Edwa98a] consider the available options from different points of view.

[2590] [Micr98p]

[2591] See [Kohn98]. The security of frames inside the *HTA* container page may be set to trusted or not trusted. The *HTA* itself and its trusted frames are liberated from all security restrictions and may, hence, access system functionality freely. Frames that are not trusted will be liable to the usual security restrictions of *Internet Explorer.*

[2592] See [MF98] and [Fole98a-b].

Last but not least, *Internet Explorer* will include wide support for a variety of *XML* technologies, to which we will now pay heed.

1.2.26 XML

Inasmuch as quite a few *XML*-based technologies, including *CDF (Channel Description Format), OSD (Open Software Description), Chromeffects, XML scriptlets,* and *HTCs (HTML Components),* already have been dwelt upon, it seems to be about time *XML per se* was attended to. Similarly to *HTML,* Tim Berners-Lee's *Hypertext Markup Language,* the *eXtensible Markup Language (XML)* is a language intended for the *markup* of text through *tags,* i.e. pieces of meta-data adding some kind of information to the text. In contrast to their *HTML* relatives, *XML* tags are, however, not primarily intended for the task of defining how data are to be *displayed,* but for the declaration of the "the storage layout and logical structure"[2593] of a document, i.e. what data *mean.* Hence, *XML* tags often take on the rôle of *semantic tags.* Also in contrast to *HTML, XML* supports arbitrarily complex *nested structures*, *validation* of these structures against a grammar known as a *DTD (Document Type Definition)*, and *extensibility* through the definition of new tags and tag attributes.[2594]

The somewhat arcane term *markup* signifies any addition of information to the text of a document – in the cant of this field, the text itself is referred to as *character data.* A distinction is made between *procedural* and *generalised markup* (also known as *generic markup). Procedural markup* appertains mainly to the formatting of the text and is widely used in, for example, word processing programmes. *HTML* is an important example of a language for *procedural markup.* By *generalised markup* is understood a *markup* exclusively concerned with document structure. For a document that has undergone *generalised markup* to be formatted for display or printing, a *style sheet* mechanism may be taken advantage of. Such a document has no fixed layout, but may be printed or displayed in any style that is appropriate for a particular purpose.

Markup languages have a long history, one of the turning-points of which was the adoption of *SGML (Standard Generalized Markup Language)* by *ISO (International Organization for Standardization)* as the *ISO 8879* standard in 1986.[2595] *SGML* is a *metalanguage,* i.e. a language for defining other languages, or rather for defining generalised markup languages. A markup language defined in *SGML* is called an *application* of *SGML,* and the language definition is referred to as a *Document Type Definition (DTD).* The *DTD* provides, as it were, a grammar for a class of documents. An *SGML* document should contain its own *DTD,* which is to say that it will be self-describing. One important application of *SGML* is *HTML,* whose more recent versions (2.0, 3.2, and 4.0) have been formally defined by *DTDs. HTML* documents do not need to include the *DTD,* since the definition of *HTML* is fixed – indeed if they did, they would become far too bulky for efficient *Internet* use. Besides, most *HTML* viewers are very lax as far as compliance with the *SGML DTD* is concerned – and, to be sure, as far as compliance with *HTML* is concerned as well. In general, *HTML* viewers are, for example, in the habit of ignoring any errors encountered rather than reporting them to the user.

Although *SGML* is in rather wide use for advanced document handling and a plethora of document editors and other tools supporting *SGML* exist[2596], its dissemination has been considerably stunted by its complexity. It has long since been realised that a more lightweight markup metalanguage, easier both to implement and to understand, is needed.[2597] Additionally, the special requirements of the web should be heeded by the language constructors. Still the advantages of *SGML,* such as flexibility, extensibility, and support for complex document structures as well as for the validation of complexly structured documents, must not be jettisoned

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[2593] [BPS98]

[2594] The literature on *XML* is rapidly expanding, although, unfortunately, the books tend to become dated very quickly after they appear in print. [Ligh97] provides one estimable account of *XML,* [Brad98] another more recent one. [Conn97] is a special issue of the *World Wide Web Journal* containing a number of important papers on *XML* as well as various *W3C* working drafts on *XML.* The current specifications of *XML* and related technologies as well as a wealth of other *XML*-related materials are available on the *W3C XML* web page http://www.w3.org/XML. [MFDG98], [Mese98a], and [Biss98] are short recent articles surveying *XML. XML* is currently in an intense phase of development, and, consequently, some of the particulars of the technologies covered in this section, which mirrors the state in December 1998, may be expected to change.

[2595] [ISO86]

[2596] [MFDG98] p. 62 speculates in passing that "more than 150 SGML software packages will be fitted with an XML output filter".

[2597] [Conn97] p. 5 et seqq.

or diluted by a new language. During 1996, the work on such a new language was instigated by *W3C* and a first working draft was announced in November of this year. The work on *XML* has since been pursued under the auspices of the *W3C XML Working Group* chaired by Jon Bosak of *Sun,* and in February 1998, *W3C* finally ratified the *XML 1.0* specification.[2598]

XML is a subset of *SGML,* and, just as its ancestor, it is a metalanguage meant to be used for the definition of markup tags for various purposes. New tags may – and probably should – be defined in a *Document Type Definition (DTD),* which will specify the valid elements[2599] – i.e. the tags – of a document or *XML* application, as well as the allowed attributes, the correct notation, etc. The *DTD* does not have to accompany each document – since many documents are expected to travel across slow *Internet* connections, document size should be kept at a minimum and enclosed *DTDs* will probably only be used in special cases. An *XML processor* may check *XML* documents for errors to assure that the document is *well-formed* and, optionally, *valid.* An *XML* document is said to be *valid* if it is associated with a *DTD* through a *document type declaration* and conforms to this *DTD* grammar. If the *DTD* is not available, the document may still be checked for *well-formedness,* i.e. compliance with the general rules of *XML.* Validation may be expected to take place primarily when *XML* is edited or emitted, whereas the checking for well-formedness will probably often be done in *XML* viewers as well. The *DTDs* of *XML* have been criticised for using another syntax than *XML* itself and for various limitations, such as lacking support for typing[2600], inheritance, presentation rules, etc. Work is going on in the *W3C XML Schema Working Group* to address these shortcomings, and a variety of proposals and prototypes attempting to overcome them have appeared, such as *Microsoft's XML Schema and Data Type Preview.*[2601]

A very simple, but as far as content goes quite typical[2602] *XML* document may look like this:

```
<?xml version="1.0"?>
<!DOCTYPE EmployeeSlip SYSTEM "employee.dtd">
<EMPLOYEESLIP>
   <EMPLOYEE position="wit">
      <FIRSTNAME>Samuel</FIRSTNAME>
      <LASTNAME>Johnson</LASTNAME>
   </EMPLOYEE>
   <EMPLOYER>
      <COMPANYNAME>Lexicography Inc., London</COMPANYNAME>
   </EMPLOYER>
</EMPLOYEESLIP>
```

The *XML declaration* on the first line, giving the version number of the *XML* language used in the current document, is not mandatory, but ought to be included in all *XML* documents. An *XML* processor should only accept files with version numbers it supports. On the second line is an optional *document type declaration,* including a reference to the file holding the *DTD* of the document. The *DTD* or parts of it can also be embedded in the *document type declaration.* Referenced and embedded *DTDs* may be combined and are referred to as the *external* and *internal DTD subset.* On line three, the *document instance,* that is to say the *XML* document proper, starts. On the fourth line, the `position="wit"` statement provides an example of an *attribute,* i.e. a name-value pair associated with an element. We will not delve further into all the details of *XML* syntax – the above simplistic example should impart some of the general flavour of *XML* documents. Through a *Document*

[2598] [BPS98]

[2599] An *XML element* consists of a *start-tag, content,* and an *end-tag:*

```
<TAG>content</TAG>
```

If content is lacking, an *empty-element tag* may be used instead: <TAG/>

[2600] See [Ligh97] p. 319 et seq. and [MFDG98] p. 64.

[2601] See below p. 566.

[2602] [Micr98π] mentions a number of categories of structured information that may be useful to deliver to the desktop in *XML* format: "financial transactions, news updates, weather information, patient records, and legal libraries".

Object Model (DOM) provided by, for example, a web browser a client may explore and access the elements of an *XML* page programmatically.[2603]

XML documents will be particularly useful for electronic forms of different kinds, such as invoices, orders, etc, but *XML* may be felicitously used for about any serialised textual data that would increase their own usefulness by exposing their semantic or structural purport. One interesting possibility worked on by *Microsoft* and *W3C* is to embed chunks of *XML* inside *HTML* pages as *data islands*. These may be used to add semantic information to an *HTML* page, e.g. about the subject of the page or the import of particular elements on it.

1.2.26.1 Ancillary XML Technologies

Under the auspices of *W3C*, work is pursued on a wealth of different new technologies related to *XML*.[2604] Some of these are simply *XML* vocabularies for special application areas, whereas others deal with the more fundamental aspects of *XML*. Among the latter, the *XML Namespaces* specification, which was adopted by *W3C* in January 1999[2605], introduces a *namespace* concept, which will ensure that *XML* tags from different vocabularies do not clash. The *local part* of any tag may be qualified with a *namespace prefix,* which is mapped to an *URI (Uniform Resource Identifier)* through a *namespace declaration*.[2606] Conceivably, namespace references will become mandatory for all *XML* tags in the future.

In order to transform an *XML* document to a form suitable for presentation, such as *HTML, style sheets* may be relied upon. By shifting style sheets, it will be possible to change the formatting of the document in order to adapt to the different requirements dictated by, for example, publication on printed paper and publication on a web page. Style sheets may also be used to disentangle code that takes advantage of the proprietary features of different web browsers. *Cascading Style Sheets (CSS)* provides a simple, but not particularly powerful style sheet mechanism geared towards web publishing. At the other end of the gamut, the *Document Style Semantics and Specification Language (DSSSL)* of *SGML* yields maximum flexibility at the cost of considerable complication and a *Scheme*-like syntax.[2607] The *eXtensible Stylesheet Language (XSL),* currently a *W3C* working draft[2608], is an attempt at a middle road. *XSL* will be considerably more flexible than *CSS* – for instance, it will be possible to reorder, sort, and filter elements – and is expected to support various advanced presentation features, although these have currently not been finally specified. An *XSL* style sheet consists of *template rules* (also known as *construction rules),* which associate *XML patterns* with *templates*. The *templates* specify *formatting actions* and will be instantiated to form part of the *result tree* during parsing.[2609] An *XSL* processor performs a

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[2603] [ABCI+98] is the *W3C DOM* specification.

[2604] Late in 1998, [Cove98b] stated that in all over 75 "XML-related specifications or new XML-based markup languages" had been announced since the initial *W3C* release of *XML*, although, of course, many of these will not have been submitted to the *W3C*.

[2605] [BHL99]

[2606] The *namespace prefix* is separated from the *local part* through a colon:

```
<namespace:tag>
```

A *namespace declaration* is made through a special *xmlns* attribute of the *XML* element, in which it will be used. The *namespace declaration* associates a *namespace prefix* with a *namespace name* couched as a *URI:*

```
<elem xmlns:namespace='http://www.dna.lth.se/epers'>
```

[2607] [ISO96a]

[2608] [CD98]. Cf. also [Biss99] and [Ligh97] p. 179 et seqq.

[2609] This simplistic example of a two-rule style sheet – appropriated from [CD98] – should give the flavour of the approach:

transformation from an *XML source tree* into a *result tree,* which will then have to be interpreted in order to produce formatted output. The result tree may be expressed in the *XSL formatting vocabulary,* which every compliant *XSL* processor should be capable of interpreting directly, or in another vocabulary, in which case the emitted tree will have to be fed to an external interpreter. It is expected that *XSL* will be frequently used to transform *XML* into *HTML* for display on web pages, although formatted output suitable for other kinds of output devices, such as printers or speech synthesisers, may be produced as well – or, indeed, output not intended for any output device at all. As the tree emitted by an *XSL* processor may be expressed in any vocabulary – e.g. in plain *XML* –, the *XSL* processor may be viewed as a general pattern matching transformation tool.

Through its *hyperlinks, HTML* supports only the most basic type of unidirectional linking out of the much larger set of linking varieties provided in classical *hypertext* systems.[2610] Support is, for instance, lacking for bi-directional links, for links to multiple targets *(cluster links)*, and for links from multiple sources *(aggregate links)* as well as for features such as link types and link attributes (i.e. attribute/value pairs associated with a link). Nor is *transclusion,* i.e. Ted Nelson's mechanism for inclusion of a target document into a linking source, catered for.[2611] Yet, the most obvious drawback of *HTML hyperlinks* will be the fragility stemming from the lack of link management facilities – indeed, one of the most trying curses of the *World-Wide Web* is the broken link.

As is the case for style sheets, there exists a full-blown, but complex *SGML*-related *ISO* standard for hyperlinking, the *Hypermedia/Time-based Structuring Language (HyTime)*[2612]*,* which together with the *Text Encoding Initiative Guidelines (TEI P3)* forms an important starting-point for the work on the somewhat simpler *XML* linking specification known as the *XML Linking Language (XLL),* or *XLink* for short.[2613] In addition to *simple links,* which approximate *HTML* hyperlinks with some added features, *XLink* will also provide support for *extended links.* These may be used for various sophisticated schemes such as multi-ended linking and linking from documents that by themselves cannot contain links. To support features like these, *indirect links* – i.e. links stored separately from the link source – are used in *XLink*. Moreover, indirect links may be used to alleviate the problems with broken links. Both for simple and extended links, it will be possible to take advantage of certain link attributes in order to, for example, associate a *role* – i.e. a type – with the link or the target document or to specify whether the document linked to should replace the current document, be embedded in it, or be displayed in a new window. A supplementary *XML Pointer Language (XPL),* also referred to as *XPointer,* adds support for pointers into the internal structures of an *XML* document.[2614]

The *XML Document Object Model* is an *API,* which provides programmatic access to the elements of an *XML* document. The *XML Document Object Model* is defined by the *Document Object Model* specification

---

```
<xsl:stylesheet
    xmlns:xsl="http://www.w3.org/TR/WD-xsl" xmlns:fo="http://www.w3.org/TR/WD-xsl/FO"
    result-ns="fo">
    <xsl:template match="/">
        <fo:page-sequence font-family="serif">
            <xsl:process-children/>
        </fo:page-sequence>
    </xsl:template>
    <xsl:template match="para">
        <fo:block font-size="10pt" space-before="12pt">
            <xsl:process-children/>
        </fo:block>
    </xsl:template>
</xsl:stylesheet>
```

The `result-ns="fo"` attribute signifies that the *XSL formatting vocabulary* is to be used. The use of separate namespaces for the *XSL* style sheet syntax and the *XSL formatting vocabulary* may also be noted. The `<xsl:stylesheet>` tags are used to delimit the style sheet inside an *XML* document.

2610 See [Bosa97] p. 225 et seq. Cf. also [Conk87] p. 33 et seqq., [Nels92] p. 4/41 et seqq., and [Land97] p. 11 et seqq.

2611 [Nels95]

2612 [ISO97]

2613 [MD98a] Cf. also [Ligh97] p. 147 et seqq.

2614 [MD98b]. An *XPointer* may be used as a *fragment identifier* after the # sign in a *URI* in order to specify a position inside an *XML* document.

recommended by *W3C*.[2615] The *DOM* exposes the *physical* element structure of an *XML* file as a tree for the client to browse and modify. Navigating the element tree may be useful for some tasks, but may be awkward for others that need to access the *logical* structure of the file, perhaps through semantically meaningful concepts such as "invoice number", "customer", "author", etc.

The *Resource Description Framework (RDF)* specification, which was adopted by *W3C* in February 1999[2616], provides facilities for such "logical" access. *RDF* is intended as a framework for meta-descriptions of web data and is supposed to enable various kinds of automated processing of web resources.[2617] It consists of a model for representing metadata about resources and an *XML* syntax for the encoding of such metadata, although, in principle, it will be possible to associate the *RDF* model with a non-*XML* syntax as well. Use of *RDF* is envisioned for tasks such as:

- *resource discovery* by, for example, search engines
- *cataloguing* of content and content relationships at web sites
- *knowledge sharing* and *knowledge exchange,* perhaps through the intermediation of software agents
- *content rating,* for example in order to keep offensive material away from children
- registration of the *intellectual property rights* of web pages
- registration of the *privacy policies* and *preferences* of users and web sites.

RDF-Schema is a related specification, which supports a class-based type system through an *XML*-based schema specification language.[2618] Another schema definition technology that may turn out to become important is the *Microsoft*-backed *XML-Data,* which allegedly is a superset of *RDF-Schema* and is partially supported in *Microsoft's XML Schema and Data Types* preview. Schemata, stored separately from *XML* data files or as an embedded part of them, will define the meaning, constraints, and relationships of *XML* elements more precisely than is possible through the current *Document Type Definitions (DTDs).* Access to the logical structure of *XML* posits schemata that define this logical structure rigorously. The schema-based support for *data types* will also be crucial to the use of *XML* to achieve interoperability between applications – interoperable applications need to agree on both the meaning and the type of *XML* elements in order to communicate efficiently. *Inheritance* of schemata will make it possible to specialise and customise an existing schema in an object-oriented manner. Unlike *DTDs,* schemata will use ordinary *XML* syntax, which possibly will make them easier both to compose and to comprehend.

Work on a query language for *XML* is also currently going on, and various proposals have been presented *(XQL, XML-QL).*[2619] Such a query language will provide yet another way of accessing data more easily and more naturally than is possible with the current *XML DOM*.

The use of *XML* as a marshalling format in order to facilitate *Remote Procedure Calls* over *HTTP* is another interesting recent development, believed by many to have exciting prospects.[2620] By using *URIs* to address objects available on the web and *XML* to encode remote calls to the methods of these objects, a rather seamless integration between the world of objects and the world of web pages may be brought about. A

[2615] [ABCI+98]. Parts of this specification apply to *HTML* only.

[2616] [W3C99]

[2617] [LS99]. There is a variety of *XML* meta-data technologies and proposals in the air, such as the *Document Content Description (DCD)* (see [BFM98]), an *RDF* vocabulary designed for the description of different types of constraints for *XML* documents, and *XML-Data* (see [LJMT+98]), an *XML* vocabulary for more advanced schema definition than is possible with plain *DTD*. *XML-Data*, which has been conceived by *Microsoft* and some other companies, forms the basis of both *DCD* and *Microsoft's XML Schema and Data Types* preview for *Internet Explorer 5.0*. Earlier metadata proposals submitted to *W3C* include the *Meta Content Framework (MCF)* developed by *Netscape* (see [GB97]) and *Web Collections* from *Microsoft* and *IBM* (see [Hopm97]).

[2618] [BGL98]

[2619] [RLS98] and [DFFL+97]. Cf. also http://www.w3.org/TandS/QL/QL98/Overview.html. *XQL* is backed by *Microsoft* and others and is supported in the *Internet Explorer 5.0* beta 2.

[2620] [Carl98]

number of different technologies supporting *RPC* over *XML* have recently seen daylight. *WebBroker* from *DataChannel* is one, which has been submitted to *W3C* as a note[2621], whereas w*ebMethods* offers another variant called *XML/RPC* in its *B2B Integration Server*[2622] and *UserLand Software* promotes *RPC-XML,* which is used in the *Frontier* product from this company.[2623] The example below was borrowed from the specification of *UserLand's RPC-XML* and shows how a simple method call may be encoded in *XML.*

```
<?xml version="1.0"?>
<methodCall>
   <methodName>examples.getStateName</methodName>
   <params>
      <param>
         <value><i4>41</i4></value>
      </param>
   </params>
</methodCall>
```

The need for data type encoding (the <i4> tag) should be noted. An *XML* message, holding any values passed back by the method and, if necessary, error information as well, will be returned upon method completion.

Reportedly, *Microsoft* is working together with *UserLand* and *DevelopMentor* on an *RPC* over *XML* technology called the *Simple Object Access Protocol (SOAP),* which is intended for use over the web for *DCOM* invocations on top of *HTTP.*[2624] However, *SOAP* – as well as the competing technologies for *RPC* over *XML* – may easily be generalised into a universal bridge – the object called may be a *COM,* a *CORBA,* or a *Java* object, or an *OpenDoc part,* provided there is server-side support for translating the *XML* message into the proper type of method call and provided the argument types used in the *XML* message comply with the type system of the technology used to package the object. By, as it were, circumventing the wire protocols of object distribution – *DCOM, CORBA, RMI,* or *Apple Events* –, *XML*-based *RPC* renders the choice between these technologies considerably less stark and less crucial than is the case currently. This may turn out to be a consequence of some import. Symptomatic of the significance imputed to this kind of technology will be the launch of an *XMLTP* "community effort" to create an "open" standard for *XML*-based *RPC.*[2625] Somewhat related is the trend to add *XML* support to *application servers.*[2626]

Not only may method calls be textually encoded in *XML,* but so may the data contained in the objects themselves. Objects serialised as text marked up with *XML* tags may be transmitted across a network and instantiated on a foreign machine, provided the binaries of the object are available there, or are made so. This approach is taken for the serialisation of *JavaBeans* into *XML* format in the *Coins* proposal, which is currently worked out by *JXML, Inc.*[2627] In a future version of *Enterprise JavaBeans* code-named *Moscone, XML* will be used

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2621 [TL98]. Cf. also [Walsh98e] and [VW98].

2622 See [webM98b] and [Thom98].

2623 [User98]

2624 See [Walsh98b] and [Wine98a-b]. There is currently almost no official information from *Microsoft* about the *SOAP* protocol, except that according to [Micr98σ] *SOAP* is used by *Microsoft's Remote Data Service (RDS)* in the most recent version (2.0) of *Microsoft's* data access technology *ADO (ActiveX Data Objects),* released in August 1998. For a discussion of *RDS,* see below p. 614. The *COM Internet Services (CIS),* which is a piece of software included with the recent releases of *DCOM,* provides support for *DCOM/HTTP Tunneling* (also referred to as *Tunneling TCP* or *Tunneled TCP)* in order to enable client/server *DCOM* communication across the *Internet* in a manner compatible with *Internet* firewall and proxy technology. By means of the *ciscnfg* utility, *CIS* may be configured to use *HTTP* as its transport protocol or as a fallback, if *TCP* cannot be used, and it may also be configured to use *RPC.* Little is currently known about the inner workings of *CIS* and its relation to *SOAP,* if any. See [Micr98k-l]. Cf. also [Micr96g] p. 40 et seq.

2625 See [Walsh98c] and [Roy98]. Well-known "open source" efforts include the *Linux* operating system, the *Apache* web server, and the *Mozilla* effort for the development of new versions of *Netscape Navigator.* [Raym98a-b] provides a kind of manifesto for open source development.

2626 See [Wong98] and [Wong99b]. For a discussion of *application servers,* see below p. 576.

2627 See [Rabi98] and [Walsh98d].

to describe the data structure of beans in order to facilitate automatic, portable container-managed bean persistence.[2628]

1.2.26.2 XML Applications

XML is a metalanguage that may be used to define *DTD* grammars for new *XML* markup languages, commonly referred to as *applications* of *XML* or *XML vocabularies.* In the future, the more sophisticated schema facilities currently in gestation will probably be preferred to *DTD* for this task. Several *XML vocabularies* for various ends have been developed or are in the process of being developed. Much of the definition work is pursued under the aegis of *W3C,* although some vocabularies will be put together by separate groups or companies, in particular in case the tag set and *DTD* grammar are specific to a certain "vertical" branch of industry or commerce.[2629] Some of these independently assembled vocabularies will finally be submitted to *W3C* in order to get the cachet of this prestigious organisation, whereas others will remain proprietary technologies or be hallmarked by some industry-specific consortium or group. Important examples of *XML vocabularies* include:

- *CDF (Channel Definition Format)* is a vocabulary for defining the kind of channels used in *Microsoft's Active Channel.* It has been submitted to *W3C* by *Microsoft.*[2630] Another *XML* vocabulary and protocol for "push" content distribution is *ICE (Information and Content Exchange),* which "manages and automates establishment of syndication relationships, data transfer, and results analysis".[2631] *ICE* has also been submitted to *W3C.*
- *OSD (Open Software Description Format)* is an *XML* vocabulary for defining packages for automatic software distribution and has been jointly submitted to *W3C* by *Microsoft* and *Marimba.*[2632]
- *OFX (Open Financial Exchange)* is an *SGML*-based vocabulary for the exchange of financial data used in, for example, *Microsoft Money* and *Intuit Quicken.* It is being converted to *XML* by *Microsoft* and others.
- *XML/EDI* is an initiative that aims at making *XML* the basis for *EDI (Electronic Data Interchange),* a tagging-based technology for the exchange of electronic forms over data connections currently using legacy protocols such as *EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport)* and *X12.* Gateways to existing systems dependent upon these formats will also be needed.[2633]
- *WebDAV (Web Distributed Authoring and Versioning)* is an *IETF RFC* on a set of proposed extensions to the *HTTP* protocol needed to enable distributed authoring and versioning of documents over the web.[2634] *WebDAV,* which makes extensive use of *XML* for the encoding of parameters and suchlike, is expected to offer document access capabilities across the web similar to those found in *LANs* today.[2635] Currently, it is supported in beta versions of *Microsoft's Internet Explorer 5.0, Office 2000,* and *Windows 2000* as well as in software from many other companies.

[2628] See [Roma99a], [Roth99], [Byou99], and [Sun98d].

[2629] For example, *Ontology.Org* (see http://www.ontology.org) is an organisation working on *XML vocabularies* for e-commerce.

[2630] [Elle97]

[2631] [WCHL+98]

[2632] [HPT97]

[2633] For more information on the *XML/EDI* initiative, see http://www.xmledi.net and [Brya98]. Support for *digital signatures* will be another important component of *XML*-based *EDI* functionality. A specification for *digital signatures* is currently being worked on by *W3C.*

[2634] See http://www.ietf.org/html.charters/webdav-charter.html.

[2635] Cf. [Micr99e], where the great expectations widely cherished regarding *WebDAV* are thus summarised: "WebDAV has the potential to revolutionize the Web, turning it into a global file and data management system."

- *XMI (XML Metadata Interchange)* is an *XML* technology currently worked on by the *Object Management Group (OMG).* It aims at "easy interchange of metadata between modeling tools (based on OMG UML) and metadata repositories (OMG MOF based)".[2636]

- *CML (Chemical Markup Language)* is an *SGML* application intended for describing molecular structures and other data of chemical relevance. It has recently been converted into *XML.*[2637]

- *MathML (Mathematical Markup Language)* is a *W3C* recommended specification[2638] of an *XML* vocabulary for describing mathematical formulae and expressions and displaying them on web pages.

- *SMIL (Synchronized Multimedia Language)* is a *W3C* recommended specification for an *XML* vocabulary for the integration of independent multimedia elements – typically streaming audio and video – into synchronised TV-like multimedia presentations.[2639]

- *HTML+TIME (Timed Interactive Multimedia Extensions for HTML)* is a proposal submitted to *W3C* by *Microsoft, Macromedia,* and *Compaq/Digital,* purportedly extending the *SMIL* concepts from media authoring tools and players to *HTML* and web browsers by facilitating the addition of timing and synchronisation constraints to *HTML* elements.[2640]

- *VML (Vector Markup Language)* and *PGML (Precision Graphics Markup Language)* are two *Scalable Vector Graphics (SVG)* submissions to *W3C,* both providing *XML* vocabularies for doing vector graphics on web pages. *VML* is backed by a group consisting of *Microsoft, Hewlett-Packard, Autodesk, Macromedia,* and *Visio,* whereas *PGML* has been developed by another group dominated by *Adobe,* but also backed by *IBM, Netscape,* and *Sun.*

- *WIDL (Web Interface Definition Language)* from *webMethods, Inc.* is "a metalanguage that implements a service-based architecture over the document-based resources of the World Wide Web" and "allows interactions with Web servers to be defined as functional interfaces that can be accessed by remote systems over standard Web protocols". *WIDL* is based on the *XML/RPC* mechanism and is used in the *B2B* product of *webMethods.* It has been submitted to *W3C* as a note.[2641]

1.2.26.3 Support for XML in Internet Explorer and Other Microsoft Products

Microsoft has endorsed and embraced *XML* fully and wholly, as is apparent from its zest with the *W3C XML* activities as well as from the wide support for *XML* provided or planned in *Internet Explorer* and some other *Microsoft* products.[2642] In *Internet Explorer 4.0, XML* is supported by the *MSXML Parser*[2643] and the *XML Data Source Object (DSO).* The *XML Data Source Object (DSO)* is a *Java* applet, which enables a programmer to access *XML* data from, for example, a script on an *HTML* page through the *DHTML data binding* mechanism,

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2636 See [UICO+98] and [OMG99a].

2637 [Murr97b]

2638 [IMBD98]

2639 [Hosc98]

2640 See [SYS98]. *Microsoft* has been markedly tepid about *SMIL,* and it seems that *HTML+TIME,* at least partly, is to be understood as a counter-proposal to *SMIL,* which is obliquely criticised for e.g. "nonstandard layout capabilities" and lack of a *document object model* in some *Microsoft* documents, such as [Micr99e].

2641 See [Alle97] and [MA97].

2642 Abundant information on *Microsoft's XML* technologies is available in the *XML* workshop pages of *Microsoft's SiteBuilder* site at http://www.microsoft.com/workshop/xml. [Micr98ν-ξ] provide brief surveys of *Microsoft's XML* technologies. Although *Microsoft* currently seems pre-eminently devoted to supporting the various *XML* technologies in the offing, *Netscape* and *Sun* are also working assiduously on support for *XML* in *Navigator, Java,* and *Enterprise JavaBeans,* respectively. Cf. [Walsh98a], [Byou99], [Sun99c], and [Guha98].

2643 [PSLL+97]

as described above.[2644] The non-validating *MSXML Parser ActiveX* control shipped with *Internet Explorer* may be used to transform an *XML* file into a tree structure that may be accessed through the *XML Document Object Model (DOM)*[2645] *API* by, for example, a script in order to extract or add information or to display the contents of the *XML* file.[2646] For example, *CDF* and *OSD* files are handled by *Explorer* through the *XML DOM* in this way. There is also a validating *Java* version of *MSXML* co-developed by *DataChannel* and *Microsoft*. This validating parser has recently been integrated into the latest version of *Microsoft's Java Virtual Machine,* which, for instance, will be used in *Internet Explorer 5.0.*[2647]

In *Internet Explorer 5.0,* the support for *XML* will be significantly expanded.[2648] The feature list will include:

- an enhanced, fully *W3C XML 1.0* compliant version of the *XML* engine of *Internet Explorer 4.0,* providing support also for *XML* validation and namespaces
- partial support for *XSL,* as specified by the *W3C* working draft[2649], augmented with the querying capabilities of the *XQL (XML Query Language)* proposal developed jointly by *Microsoft, webMethods,* and *Texcel* as a "a set of extensions to XSL"[2650]
- direct browsing of *XML* files using *XSL* or *DHTML Cascading Style Sheets*[2651]
- full support for the *W3C XML Document Object Model*[2652]
- a preview version of *XML Schema and Data Types, Microsoft's* technology for creating richer schema definitions for *XML* documents than is possible with plain *DTD*[2653]
- support for *XML Data Islands* embedded in *HTML* files through an <XML> tag in accordance with a note published by *W3C*[2654]
- the *Java* applet implementation of the *XML Data Source Object (DSO)* as well as a new faster *C++ DSO,* providing support for both the *XML* and the *ADO* object models

Besides *Internet Explorer, Microsoft* has added support for *XML* features to some other products as well.[2655] For example, the *Site Server, Commerce Edition* supports *XML* data exchange between applications over *HTTP*. More significantly, in *Office 2000* there will be an option to save a document as an *HTML* file annotated with *XML* so as to preserve all the formatting of the original document. Such an *HTML/XML* file may be reopened in *Office* with no loss of formatting information – this is in contrast to the *Save as HTML* function of *Office97,* which just scraps large parts of the formatting and even some text contained in elements such as footnotes, footers, etc. that cannot be displayed on an *HTML* page. We have already touched upon the planned support for *WebDAV* in *Office 2000* and *Windows 2000.*[2656] Last, but possibly not least, *Microsoft* is working on the *SOAP (Simple Object Access Protocol)* in order to support *remote procedure calls* – and thus *DCOM*

2644 See above p. 556.

2645 Some *Microsoft* documents, such as [Micr98π], also use the term the *XML Object Model (XML OM).*

2646 This is useful, as there is no direct support for *XML* browsing in *Internet Explorer 4.0.*

2647 Originally, this parser had to be downloaded from *DataChannel's* web site.

2648 See [Micr98*o*], [Micr98ρ], and [Hein98].

2649 Currently, only the transformation part of *XSL* is supported by the *MSXSL* processor, whereas the *XSL formatting vocabulary* is not. This is expected to change, as the *W3C* specification consolidates.

2650 See [webM98a] and [RLS98].

2651 If no style sheet is specified, a default style sheet will be used.

2652 *Microsoft* has also added various extensions to the *W3C DOM* in order to support namespaces, data types, schemata, and asynchronous document loading.

2653 This technology is supposed to change, as the *W3C* schema definition effort proceeds.

2654 [CD98]. The *XML* data may be either embedded directly in the *HTML* file or indirectly referenced through the *URL* of an *XML* file.

2655 See [Micr99e].

2656 See p. 568.

calls – over *HTTP* by transforming these into *XML* messages.[2657] *SOAP* is reportedly used by the *Remote Data Service (RDS)* of *ADO 2.0,* and it may in the future become an important part of *Microsoft's* plumbing technologies.[2658]

1.2.26.4 XML – Plaudits and Brickbats

XML has met with wide approval, and the *W3C XML Activity* has not become the venue of strife and squabble that one might have expected from the grating controversies surrounding browser technology in general, being apparent in, for example, the different dialects of *DHTML* – to say nothing of the embittered brawl over distributed object and component technologies. On the contrary, *Microsoft, Sun, IBM, Netscape,* and many other companies have been able to co-operate and co-edit the *XML* specifications without any major skirmishes.[2659] One reason why this has been possible may be that *XML* is not yet accredited with as strategic importance as for example *Java, DHTML,* components, or distributed objects. On the whole, it is uncertain or even doubtful whether the success of *XML* or this or that *XML* technology would benefit *Microsoft* or the so-called *NOISE (Netscape, Oracle, IBM, Sun, and Everyone else)* alliance[2660] more than the other camp. This lack of a clear-cut strategic portent will, in turn, ensue from the circumstance that the benefits and consequences of *XML* are neither very well, nor very widely understood, notwithstanding the fact that *XML* indeed has attained the irresistible mesmeric allure of a true buzzword, compelling allegiance from all the major dramatis personae of the computer business.

Unquestionably, there are important benefits to be gained by the use of *XML*. In a frequently cited paper, Jon Bosak, chairman of the *W3C XML Activity,* has suggested four "applications that will drive the acceptance of *XML",* as they will accomplish feats not possible in plain *HTML*:[2661]

- *Data exchange* between different applications with heterogeneous databases may be used for *EDI (Electronic Data Interchange)* functionality and the like, e.g. between medical records and other health care systems, legal publishing systems, collaborative systems of different kinds, insurance, securities, and banking applications, etc.
- *Distributed processing* may make processing of data more responsive and decrease server load at that. Distribution may be brought about through the download of data packaged as *XML*-tagged documents together with an applet or other type of downloadable component that lets users process or explore data locally. This approach will only pay off, in case the user will spend considerable time on processing the data. Possible uses include (not too complicated) design applications, travel scheduling programmes, *CAI (Computer-Aided Instruction)* and help systems, support and maintenance manuals, and the like.
- *View selection* will enable users to view downloaded data in multifarious ways without having to download data ever and again when switching views and may be used for dynamically building navigable tables of contents or for facilitating switching between different languages, sorting orders, and modes of display. It will be further generalised by *XSL*.
- *Web agents* that know about the preferences of a user (e.g. through *XML/RDF* declarations) may on his behalf search documents tagged with *XML/RDF* meta-data for information of interest. Evidently, such meta-data may equally well be taken advantage of by *Internet* search engines in order to enhance the validity and relevance of search results.[2662]

[2657] Cf. p. 567 supra.

[2658] Cf. [SH98] p. 15 et seqq. and p. 171 et seq.

[2659] [Walsh98c] recounts some minor cracks in the peaceful façade.

[2660] Sometimes this unofficial alliance is also referred to as *ABM (Anyone But Microsoft).*

[2661] [Bosa97] p. 220 et seqq.

[2662] [Carl98] briefly discusses some current work on *XML*-based agent communication.

To these useful "applications" may be added others, such as the possibility of taking advantage of *XLL* for link management.[2663] Tasks as the above may, of course, be achieved by the clever use of scripts, applets, plug-ins, and *ActiveX Controls,* but such techniques may implicate considerable coding efforts and will generally be less straightforward and elegant. To sum up, the potential benefits of *XML* will include:

- extensible tagging format supporting complex and deeply nested structures
- validation of documents, possibly against a *DTD* grammar
- self-describing data facilitating the use of data from disparate sources, the interchange of data between independently developed applications, and the dynamic exploration and extraction of data through the *XML* document object model
- universal marshalling format for data interchange across *RPC*-based technologies such as *DCOM* and *CORBA*
- granular updates of client/server data, involving only the updated piece of information and its surrounding tags, possibly delivered over an *HTTP* link and possibly transported in compressed format for increased performance and scalability[2664]
- *XSL* style sheets for supporting presentation and publication in different formats from a single master copy, itself unencumbered with irrelevant formatting information
- more precise and faster web search capabilities through *RDF* meta-data and agents
- advanced *XLL* linking, link tracking, and link management, possibly alleviating the affliction of the broken link

Although these boons are indeed estimable, it should be noted that there are other established formats for representing semantic meta-data for many of the applications mentioned above. For *EDI* data exchange, the *ANSI X12* and the *United Nations EDIFACT* standards have been in use for long; complex publishing of technical documentation and the like is an established stronghold of *SGML*; and for agent communication, *KIF (Knowledge Interchange Format)* and *KQML (Knowledge Query Manipulation Language)* currently bear sway. Although the diffusion of these technologies seems to have been considerably curbed by their complexity, they all have their well-established user communities, which might be more or less ready to adopt new formats and new standards.[2665] Additionally, there will be a need to create bridges to systems that stay with the legacy formats.

In many cases, some of the mentioned benefits, such as distributed processing and view selection, may be achieved much easier by using *Dynamic HTML.* And on closer inspection, some other putative benefits will appear considerably less important than perhaps thought *prima facie.* Although useful in some instances, the shifting of style sheets in order to emit different types of publications from one master document will, for instance, hardly be feasible for non-trivial documents without extensive laying on of hands. Additionally, whereas validation will certainly be a good thing in document *editors, viewers* had better stay as forgiving as the current generation of *HTML* browsers, lest we see the web increasingly beset by all kinds of obscure compatibility problems. And by marking up data, one gains flexibility at the penalty of bulk and time (markup time, increased download time, *XML* parse time, *DOM* navigation time, etc.), which, for example, may make *XML* less attractive as a delivery format for three-tier data retrieval than was originally expected. Traditional

[2663] Suggested in [MFDG98] and elsewhere.

[2664] [Micr98ν] and [Micr98π] envision middle tier agents that will extract data from multiple databases and translate them into *XML* files to be delivered via *HTTP* to the desktop, where these same data may be manipulated through the *XML Document Object Model.* In this way, data from diverse sources may be amalgamated into what will appear to the client as a single, coherent logical *XML* view. Agents may also generate *XML* updates ("updategrams") at the behest of the client, the middle-tier, or the server – depending on where the update was made – and then forward them to the parties that need to be informed.

[2665] Cf. [Cove98a], who chides *XML* for its lacking support of semantic rigour and its "very limited range of expression for modeling complex object semantics". He concludes: "For messaging and other transaction data, specifications approaching the level of formal semantics are desirable (e.g., KIF, or KQML), governing not just common (atomic) data types in business objects, but governing complex objects used by computer agents in large-scale business transactions." Cf. also [Cove98b], where the requirement for "semantic transparency" – i.e. "unambiguous" and "meaningfully correct" information – is underlined and made the corollary of a formal mechanism for the declaration of semantic integrity constraints that allow validation not only of syntax (as in today's *XML),* but also of semantics.

positionally encoded data retrieval, although rigid and recalcitrant to change, is indeed efficient, and in data retrieval, efficiency is habitually esteemed highly. Compression schemes may alleviate, but not dispel the performance penalty incurred.

For a few other of the above benefits to be gained, *XML* and some of its related technologies need to become all but ubiquitous. For instance, if search engines are to be helped by *XML/RDF* meta-data, most documents must be on *XML* format and include *RDF* meta-data tags. If this will ever happen is moot. As of today, a large number of documents on the *Internet,* being formatted as, for example, *postscript* (.ps), *Acrobat* (.pdf), or *Word* (.doc) documents rather than as ASCII files, are regularly skipped by the search indexing engines in common use. Such non-ASCII documents cannot easily be marked up with *XML* tags, whereas many ASCII ones will not be marked up for a variety of reasons, including the phlegm of human nature and the occasional requirement to provide documents as unalloyed text. Clearly, the abundance of such documents will reduce the value of *XML*-based searches materially. Likewise, for *XLL* link management to mitigate the problem of the broken link notably, the complicated indirect extended links of *XLL* must come into wide use. And for two separately developed applications to be able to exchange *XML* data ad hoc, they both need to support and understand not only *XML,* but also the same *XML* vocabularies.

In a recent article apparently motivated by the arrival of *Microsoft's XML*-based *Chromeffects,* Mark Pesce, one of the originators of *VRML,* warns against *XML* as a "tower of Babel", which threatens to balkanise the web into a plethora of proprietary dialects.[2666] One may think that this criticism misses the mark – proprietary formats have always played an important rôle on the web and those not natively supported by a web browser are taken advantage of through plug-ins, *ActiveX* controls, or *Active Document* servers. The use of *XML* for defining proprietary vocabularies will hardly be more detrimental than devising a format that is proprietary from the ground up. Additionally, proprietary formats may not be detrimental at all – they may in due time become *de facto* standards, which on the whole tend to be more usable, more useful, and more used than the often overdesigned and thence overly complex standards issued by committees.

Notwithstanding this, Pesce indubitably has a point – if vocabularies are not agreed upon and the meaning of tags will not be understood across applications, the benefits of tagging will evanesce.[2667] The need for standardisation of vocabularies is critical for the success of *XML*, and, in particular, vertical standards for different branches of industry and commerce are needed.[2668] Some of these standard vocabularies will be agreed upon and documented rigorously by industrial working groups or standardisation bodies, whereas others will be proprietary applications of *XML,* possibly first introduced into a field by a company acting as a vanguard – this company may or may not be a major player of its field – and then adopted by others as a de facto standard.[2669] However, standardisation will require support for well-defined data types in *XML,* if the goal of ad hoc data exchange shall be attained.[2670] Merely agreeing to the meaning of semantic tags will be of little avail, as long as a common understanding of the data marked up by these tags is wanting.

More fundamental in nature is the criticism of embedded markup put forth by Ted Nelson.[2671] In Nelson's view, embedded markup posits a hierarchical or sequential representation of structure that runs counter to the nature of human thought – and, to boot, sorts ill with both basic editing operations and his own notion of *transpublishing.*[2672] The anarchic and overlapping interconnections and the deep and detailed

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[2666] [Pesc98c]

[2667] It should be noted that even in case the tags of an *XML* file are not understood, the file may be correctly displayed by the browser, if only the browser has an *XSL* style sheet that knows how to display the tags. Wanting such a style sheet, the browser should still be able to display the file as primitively formatted text – with or without the tags.

[2668] There is a much more vicious balkanisation between disparate technological foundations, pursued by distinct standardisation bodies or initiatives, each of which follows its own course in order to achieve the goal of semantic interoperability between independently developed applications, components, agents, business objects, etc. *OMG Domain Interfaces, Microsoft's Industry Solutions, XML vocabularies,* and the various niche technologies mentioned *(EDI, SGML, KQML,* and *KIF)* all provide important examples of such sequestered islands of semantic endeavours.

[2669] [Cove98b] discusses the need for centralised management of *XML* namespaces and vocabularies.

[2670] Cf. [Ligh97] p. 319 et seq. and [MFDG98] p. 64.

[2671] [Nels97b]

[2672] *Transpublishing* signifies the on-line publishing of extrinsic materials as part of a document by a special kind of inclusion referred to as *transclusion.* The quoted materials are pulled from the original document without the quoting party's physically including it. This

version management needed to represent the son et lumière of associations and parallel by-ways characteristic of the human creative process are, in Nelson's view, viciously curtailed by the textual flat-out necessitated by an embedded markup format.[2673]

Pace Pesce and Nelson, in the end the foremost problem with *XML* may, however, turn out to be the very issue that it from the beginning was meant to dispel, to wit complexity. Although *XML* by itself is neither overly complex, nor very large – in particular not if compared to *SGML* –, its subsidiary *XSL* is substantially more involved, and the *XLink/XPointer* proposal makes use of a conceptually compelling patois that probably will put off many non-technical users. The success of the simplistic, easy-to-use *HTML* for web UI programming and design strikingly parallels the success of the simple, easy-to-use *Visual Basic* for desktop UI programming and design. In effect, *HTML* has become the *BASIC – Beginner's All-purpose Symbolic Instruction Code* – of tagging languages, making *Internet* web page programming come within the reach of ordinary users, similarly to the way *Visual Basic* brought *GUI* programming to the broader clientele. In contrast, *XML,* being considerably more complex than *HTML,* is geared towards a technically sophisticated audience rather than the general web public. For example, the separation of the presentation aspects from the content of the page, although *per se* a well-motivated step, will demand both more design forethought and a more profound understanding of the markup language than the off-the-cuff insertion of a few display-oriented *HTML* tags in a text.

However, it may be mistaken to judge *XML* from the standpoint of the prevailing crude and primordial habit of hand editing *HTML* text files. The complexity problems of *XML* may be at least partially kept at bay by good editing tools, screening the naïve users from the difficult or perplexing aspects of *XML.* As – at least partly – witnessed by the lasting plight of *SGML,* success for any technology will eventually depend upon the impetus it is able to muster from major market players, in products as well as in tools. Considering that both *Microsoft* and the *NOISE* camp appear to back up *XML* whole-heartedly, it will be as like as not that *XML,* for all its potential problems, will gain critical momentum. The advertised *Office 2000* support for *XML* may well become the snowball that sets the expected *XML* avalanche in motion, providing *Microsoft* will be able to make it work reasonably. From the point of view of the background theme of the current study, the most interesting and possibly most consequential of the possible future uses of *XML* will, however, be as a mechanism for semantic messaging between business objects.

mechanism of "virtual clip art" also involves a scheme for preserving the copyright of the originator *(transcopyright)* and, possibly, compensating him through automatic per-quote *micropayments* as well. For images, the *HTML* <IMG SRC> tag may be understood as providing a primitive form of *transpublishing* capabilities.

[2673] Instead, Nelson suggests a three-layered "parallel" model of representation, which also forms the foundation of the *Xanadu* system. In this architecture, the *content layer* holds the immaculate text, the *structure layer* specifies all kinds of interconnections, whereas the *special-effects-and-primping layer* contains formatting information. These layers are separately stored, possibly in separate files. While presumably catering to the structure and presentation aspects quite well, this approach seems to be lacking support for the semantic interpretation and typing of data. Possibly, a fourth layer would correct this.

1.3. APPLICATION SERVICES – TESSELLATING THE MIDDLE LAYER

Quite in the spirit of *DNA* at large, its *Application Services* attempt to exploit *Microsoft's* across-the-board component architecture *COM* as a fulcrum for the levering of middle layer client/server development into a higher-level echelon, where the tessellation approach of *COM* is expected to dispel much of both the complexity and the excessive rote work traditionally haunting such efforts.[2674] The lever of this act of elevation is provided by three paramount pieces of *middleware,* to wit the *Microsoft Transaction Server (MTS),* the *Internet Information Server (IIS),* and the *Microsoft Message Queue Server (MSMQ),* which, unsurprisingly, furnish support for transaction processing, web, and messaging services, respectively.[2675] *Microsoft's* ambitious architecture for enterprise client/server computing comprises other important middleware building blocks as well, such as the *Microsoft Clustering Server (MSCS)*[2676]*,* the *SNA Server*[2677]*,* the *Active Directory*[2678]*,* the *Exchange Server*[2679]*,* and a variety of system administration technologies gathered together under the aegis of *Zero Administration for Windows (ZAW)*[2680]*,* although, strictly speaking, none of these elements is part of the *Application Services* of *DNA*. In any case, we will let these technologies go by the wayside, since they are not crucial to the theme pursued here and considerable space and time would be needed to account for them adequately.

Obviously, *middleware* is a category of software that has its roots in the demands of client/server computing. It has aptly been characterised as "the slash (/) component of client/server"[2681], providing, as it were, the infrastructural glue needed to build distributed systems. With the advent of web-based client/server applications, middleware has grown increasingly important, and the choice of middleware infrastructure and middleware products is often one of the most difficult and critical steps of client/server development endeavours.

2674 [Micr98v] refers to the *COM/DCOM, MTS, IIS,* and *MSMQ* services in *Windows NT Server* as *Microsoft Component Services.*

2675 [Sess98a] and [Kirt99] provide thorough book-form examinations of *Microsoft's* enterprise technologies, whereas [Dolg98a] provides a decent magazine-article survey. [Sess98d] and [Saye98] contrast *Microsoft's* component-oriented middleware technologies with those of *OMG*.

2676 *Microsoft Clustering Server (MSCS),* formerly known as *Wolfpack,* and *Windows NT Load Balancing Service (WLBS),* based on the *Convoy Cluster* from *Valence Research,* are two pieces of technology providing support for clustering in *Windows NT*. They are both currently part of the *Enterprise Edition* of *Microsoft Windows NT 4.0,* which also supports *Symmetric Multi Processing (SMP)* with up to 8 processors (OEM-versions of *NT* may support up to 32 processors on special hardware), large application memory space, etc. (see [Micr97o]). Currently, *MSCS* only supports clusters of two servers and only provides fail-over functionality – possibly with a considerable fail-over delay at that –, although in the future more servers (probably up to 16) and dynamic load balancing will also be supported. In contrast, *WLBS* supports load balancing of up to 32 servers that share a "virtual" IP address. The next version of *COM, COM+,* will support load balancing at the component level. For a discussion of the central issues of scalability and availability in *Windows NT,* see [Micr98a-g], [John98a], and [KS98] p. 33 et seqq. and p. 111 et seqq.

2677 The *SNA Server* supports integration with *IBM* mainframe and mini computers. See [Micr97p].

2678 See [Micr98d] and [KS98] p. 71 et seqq. The *Active Directory* will be one of the more significant new features in *Windows 2000*. The *Active Directory Service Interfaces (ADSI),* previously called the *OLE Directory Services,* is the corresponding *API,* surveyed in [Micr98h] and treated of fully in [Hahn98]. From the point of view of client/server programming, *ADSI* provides an abstract *COM*-based naming/directory service, which may be used as an interface to a variety of extant naming and directory services, such as the *Windows NT Server 4.0* directory, the *NetWare Directory Service (NDS),* the *NetWare 3 bindery,* and the *Lightweight Directory Access Protocol (LDAP)* – used in e.g. the *Active Directory* – as well as to various *ADSI*-compliant products such as *Microsoft's* own *Exchange, Internet Information Server,* and *Site Server.*

Furthermore, *ADSI* is part of *Microsoft's Open Directory Services Interfaces (ODSI),* which in all encompasses five *APIs,* viz. *ADSI,* the *Network Provider Interface* for the support of automatic logon to multiple namespaces, *Windows Sockets Registration* for service registration, *Windows Sockets Resolution (RnR)* for service resolution, and *RPC OLE DB* for rich query. *ODSI* is in turn part of *WOSA (Windows Open Services Architecture),* a motley of – mostly somewhat aged – *Windows*-related *APIs.* In addition to *ODSI, WOSA* includes *Windows Sockets, Windows RPC, Windows SNA API, MAPI (Messaging API), TAPI (Telephone API), LSAPI (License Service API), ODBC (Open Database Connectivity), WOSA Extensions for Financial Services (WOSA/XFS),* and *WOSA Extensions for Real Time Market Data Specification.* It is noticeable that *ADSI* abstracts directory services in a way quite similar to that in which *ODBC* abstracts database access.

2679 *Microsoft Exchange Server* may be used to create collaborative and workflow applications. See [Micr99a].

2680 [KS98] p. 127 et seqq. These technologies include *Microsoft Management Console (MMC,* previously code-named *Slate),* which provides a common *Windows Explorer*-like user interface for administrative *snap-in* tools, *Web-Based Enterprise Management (WBEM),* which encompasses a series of standards that may be used to create object-oriented schemas of an administrative environment, *Windows Management Instrumentation (WMI),* which is a technology supporting surveillance and management of hardware devices, and the *Systems Management Server (SMS),* which is a product useful for automating software distribution and maintenance across a network and other related tasks.

2681 [OHE96a] p. 16

Middleware is by no means a homogeneous class of software, but comprises a variety of widely divergent sub-categories, some of the more important of which are:[2682]

- network communication software, including basic *NetBIOS* and *TCP/IP* protocol stacks and software supporting socket and named pipes communication across these as well as more sophisticated, higher-level communication facilities, such as
    - *Remote Procedure Call (RPC)* software for synchronous cross-machine programme-to-programme communication
    - *Message-Oriented Middleware (MOM)* for asynchronous cross-machine programme-to-programme communication
    - *Object Request Broker (ORB)* technology, such as *CORBA, RMI* and *DCOM,* for cross-machine synchronous (or occasionally asynchronous) object-to-object (or component-to-component) communication
- *Transaction Processing Monitors (TPMs)* ensuring transaction integrity when accessing databases and promoting scalability and reliability of business-critical applications
- database access software, typically supporting an abstraction layer, such as that provided by *Microsoft's ODBC (Open Database Connectivity)* or *Sun's JDBC (Java Database Connectivity) API,* through which the differences in access language syntax and capabilities between different *DBMS* products are ironed out
- *Internet*-related middleware such as *web* and *application servers*
- *application brokers* supporting the remoting of the user interface of an application running on a server machine to a *(Java*-capable) web browser running on a client machine[2683]
- *groupware* and *workflow* software
- systems-management middleware

As time goes on, popular pieces of middleware, originally marketed as distinct products, tend to accrete to the basic infrastructure provided by operating systems. This has, for example, happened to basic *TCP/IP* network facilities, which often were sold separately from the operating system some years ago. Currently, several of the above categories are actually about to become engulfed by operating systems, if they have not been already. In particular, the *Windows 2000* server system will incorporate most of these, except for some pieces of relatively minor importance, such as the *Exchange Server* groupware product and the *SMS* management software, which in all probability will remain separate products of the *Microsoft BackOffice* product line for the foreseeable future. Assimilation into the operating system infrastructure is a perfectly natural and evermore ongoing process and will benefit users through lower costs and standardisation, but will, unfortunately, also tend to scotch competition. At worst, lack of competition may cause technology to fossilise at its current state, although this may as well not happen for various reasons, including competition amongst different operating platforms.

The term *application services* positions the *IIS, MTS,* and *MSMQ* family within the burgeoning realms of *application servers,*[2684] i.e. the farrago of middleware products that add to the basic server operating system

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[2682] In [OHE96a] p. 16 et seqq., a distinction is made between *general middleware* and *service-specific middleware*. The *general middleware* category is made to include communication stacks, distributed directories, authentication services, network time, remote procedure calls, queuing services, message-oriented middleware, and network operating system extensions, such as distributed file and print services. The *service-specific middleware* encompasses database-specific, *OLTP*-specific, groupware-specific, object-specific, Internet-specific, and system management-specific middleware.

[2683] Examples of products of this new category of middleware will include *Citrix' WinFrame, SCO's Tarantella,* and *Insignia Solutions' NTrigue.*

[2684] The term *application server* may also designate the middle tier of a three-tier client/server system or the machine on which such a middle tier executes, in case it is run on a computer other than the database server. Occasionally, the middle tier is further divided into two or more tiers, such as a *web* and an *application* tier, which in this case may execute on separate *web* and *application server* machines. [Mese98b] reports that *Forté Software* claims to have coined the phrase *application server.* [Kara98a-b], [Gill98a-e], [Wate98], [Desm98], [Dolg98c], [Dolg99b], [Mese98b] [WAB98], [Gard98], [Paqu98], [Ricc98a-b], [Chap99], [Wong98], and [Wong99a-b] discuss *application servers* and related middleware products.

various services useful to distributed applications – and, in particular, to multi-tier web applications that integrate back-end *applications* with the web.[2685] These products are quite dissimilar in character, but may typically provide a miscellany of services pertaining to:

- database access
- transaction handling
- object request brokering
- messaging
- component management
- pooling of resources, such as threads and database connections
- data caching
- static or dynamic load balancing
- state and session handling
- state and session data replication, fail-over, and other high availability and clustering features
- security
- name/directory services
- integration with existing databases, applications (and in particular with widely used *ERP, Enterprise Resource Planning,* applications from *SAP, Baan,* and *PeopleSoft),* and mainframe systems

Some *application servers* implement *Enterprise JavaBeans (EJB)*[2686] or *CORBAservices* interfaces, and some come bundled with visual *integrated development environments (IDEs)* and administration consoles. Some have their roots in web servers, others in transaction processing monitors or database management systems, whereas others still have evolved from development or 4GL tools or from object request brokers. Most *application servers* have a strong *Java* bias, which meshes well with the waxing belief that the server rather than the client may provide the sweet spot for the *Java* language as well as with the somewhat waning credibility of *Java* as a viable and well-performing vehicle of universal *GUI* client portability.[2687] The primary driver for the current

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[2685] The *application server* market is currently simmering with activity, as small start-ups working on brand-new products mushroom up and established software manufacturers try to retrofit, reshape, or supplement existing products so as to be able to bestow the numinous label *application server* upon them. [WAB98] states that there were around 40 *application server* products available in late 1998. Some of the more important start-ups have been acquired by established companies that want to get a finger in the *application server* pie apace. For instance, *Netscape* acquired *Kiva* in late 1997 and now markets the *Kiva Enterprise Server* as the *Netscape Application Server.* Early in 1998, *Sun* purchased *NetDynamics,* and somewhat later *BEA* bought *WebLogic* in order to get hold of its *Tengah* application server. The sums paid for these elfin businesses have been spectacular – according to [BI99], *Kiva* was sold for $179 million, *NetDynamics* for $160 million, and *WebLogic* for $193 million – and reflect the high-flying expectations attached to the *application server* market. According to [Gill98b], *WebLogic* together with *IDC* prognosticated the worth of the entire *application server* market to between $250 and $400 million by the year 2000, whereas [Paqu98] cites a *Forrester Research* report, which estimates the application server market at $2000 million in revenues by 2002! Aside from those already mentioned, important products branded as *application servers* include the *Oracle Application Server, Sybase's Enterprise Application Server* (including the *Jaguar Component Transaction Server), Inprise's Application Server, Progress' Apptivity, Bluestone's Sapphire/Web, Vision's Vision Jade, Novera's jBusiness 4, Infoscape's Fresco, Silverstream Software's Silverstream, Haht's HAHTsite Application Server, GemStone's GemStone/J,* and *IBM's WebSphere,* the *Enterprise* version of which will include the *ComponentBroker* as well. Since the service *APIs* exposed by these products are largely proprietary, the classical dilemma of vendor lock-in is bound to haunt early adopters. Whereas the demand for scalable e-commerce systems forms a mighty incentive to make use of these products, their immaturity, the smallness of some of the companies producing them, and the expectations for a major shakeout amongst these as well as for the inclusion of many of the services they provide into next-generation operating systems or standard *CORBA* and *Java APIs* will offer an equally mighty disincentive.

[2686] [Sun98b] and [Sun99a] list a large number of application servers and other products, which either support or will support *Enterprise JavaBeans.* According to [Mese98b], among the first companies to fully support *EJB* are *WebLogic* with *Tengah, Persistence Software* with *PowerTier for EJB, Bluestone* with *Sapphire/Web,* and *Secant* with *Secant Extreme Enterprise Server.*

[2687] Cf. supra p. 541, [Kara98a], [Gill98e], and [Gill99]. The strong *Java* bias in these products seems to be imputable partly to the association of *application servers* with the web, which has almost axiomatically been made the realm of the *Java* programming language, partly to the current infatuation with *Java* amongst the crestfallen rank and file of *C++*-based object-oriented programming, who, embarrassed and disgruntled with the long-standing and increasingly caustic contumely and badinage of *C++* as well as with the hitherto rather puny results of the *C++* variant of the object-oriented agenda – at least as compared to the expectations that once upon a time

wave of interest in *application servers* is the increasing demand for highly scalable and highly available web applications and, in particular, for e-commerce systems with such properties.[2688] These applications are characterised by the requirement for around-the-clock availability[2689] and by the impracticality of any safe predictions of the number of concurrent users, necessitating the highest possible level of scalability.[2690] Additionally, security considerations will be of paramount importance in these systems.[2691]

MTS, MSMQ, and *IIS* have closer relations to the host operating systems than this type of *application servers,* and in contrast to most of these they are not *Java*-centric, but language-neutral in the same sense that *COM* is language-neutral. Hence – and by virtue of being part of the *Windows NT Option Pack* – these services may well be understood as optional modules of the *Windows NT* server operating system, transforming the *NT* server operating system into an application server in its own right.[2692] When *Windows 2000* is released, the integration between the operating system and the services these products provide will be further strengthened. Thus, the next version of *COM, COM+,* which itself will be an integrated part of *Windows 2000,* is supposed to assimilate *MTS* and, at least partially, *MSMQ* into a new unified and tightly integrated component infrastructure.

Although admittedly some of these *Microsoft* technologies are still not altogether mature and, in particular, scalability is widely held to be a chink in Microsoft's current armour, they will together with the *Windows 2000* operating system form an increasingly formidable and cost-efficient alternative to other server platforms, including *IBM's* mainframe systems and a plethora of *UNIX*-based systems. *Microsoft's* assault on the server market is the result of a long-ranging and very determined strategy, which also appears as a natural consequence of the lack of expansive potential of a desktop market already almost totally appropriated by *Microsoft.* These plans doubtless run counter to the vested interests of the companies that currently make their money from the non-*Windows* server market, nay, threaten to undermine the very foundations of them. This is the background of the high-pitched hue and cry against *Microsoft* from the *NOISE* group and their many and staunch devotees as well as a plethora of other countervailing measures, including both labyrinthine judiciary machinations – to sic the American anti-trust authorities on *Microsoft* will be the most spectacular deed of this kind of derring-do – and attempts to unnerve the vitality of the *desktop-centric Windows* platform through a *network-centric* or *web-centric* strategy involving *Java* as a portable operating system, the replacement of desktop computers with thin clients or network computers (NCs), the espousal of the programme of *ubiquitous computing,* etc.[2693]

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soared aloft –, will be prone to put the blame for the lack of the expected spectacular successes on purported deficiencies of the *C++* language and embrace the syntactic look-alike *Java* as *the* universal corrector of these very same faults. However, it should be noted that the byte-code execution that made *Java* so well fitted for use in web clients is not at all well suited for heavily loaded servers, where rather the performance advantages of static compilation and native execution will be needed, and that, while evidently advantageous in client web browsers, the portability and security checks made possible by byte-code execution are not of much use on servers. Additionally, although compiled *Java* may be as good a choice of language on the server as any, for server programming purposes a strong case for language-neutral technology – such as *COM* or *CORBA* – can undoubtedly be made. Cf. also [Dyck98] for some quite disappointing early test results concerning *Java*-based *application servers,* unveiling a variety of serious quality, stability, and performance problems.

2688 [KG99] cites a *Forrester Research* report that estimates the American e-business trade at $43 billion in 1998 and expects it to have grown to $1.3 trillion in 2003.

2689 Clustered servers, supporting fail-over in case of a server crash, conduce to higher availability. To be able to conceal the consequences of a failure to users, the infrastructure must also replicate state and session data across the clustered servers.

2690 Such scalability is dependent on both powerful hardware and sophisticated software. Among the software features needed are thread and connection pooling, data caching, and (dynamic) load balancing of requests across multiple clustered servers. Currently, some *UNIX* systems have an edge over *Windows NT* as far as powerful hardware and support for clustering is concerned. Cf. [Desm98] and [Dyck98].

2691 Cf. [Saye98].

2692 One may argue that the *Windows NT Option Pack,* which encompasses *IIS, MTS, MSMQ,* and some other web-related software, or the *Site Server* and *Site Server Commerce Edition,* which includes both the *NT Option Pack* and *SQL Server,* would be more properly labelled *Microsoft's application server* than *NT* itself. Since there is no consensus on the definition of the term *application server* and the relation of the above packages to *NT* is so intimate, there is, however, little reason to pettifog over which of these constellations is to be thus labelled. Cf. [Rice99].

2693 As pointed out by [Dolg98d], the very emotional debate on the pros and cons of *COM* and *CORBA* frequently disguises a discussion of whether *Windows NT* or *UNIX* is preferable as a server operating system. [Kell98a] wittily parallels the current bout of anti-*Microsoft* activity and sentiment with historical levelling commotions.

1.2.27 MICROSOFT TRANSACTION SERVER (MTS)

The *Microsoft Transaction Server (MTS),* currently being in its 2.0 appearance, has challenged much attention all since the first intelligence about the *MTS* development project – then code-named *Viper* – made its way into the public and even more so after its release as a separate middleware product in 1996.[2694] By underpinning a transaction service with *Microsoft's* component technology *COM, MTS* arguably has established a novel class of software, which extends the realms of the time-honoured software category of *Transaction Processing Monitors (TPMs* or *TP monitors)* into something entirely new. As befits a truly innovative piece of software, *MTS* has been very diversely characterised, e.g. as a "common infrastructure for developing objects in a state-conscious manner"[2695], "a general purpose application server transparently hosting COM components"[2696], an "object transaction monitor"[2697], a "component runtime environment"[2698], a "communications manager"[2699], and a "communications resource manager"[2700].

In addition, *MTS* has been averred to inaugurate a "third wave" of "state-conscious" object-oriented programming distinguished by the separation of *state* and *behaviour.* According to this exegesis, classical class-based object-orientation, bundling state and behaviour together as classes/objects, constitutes the first wave, whereas the interface-based development style of *COM, CORBA,* and *Java*, marked by the strict separation of *interface* and *implementation,* represents the second wave.[2701] Nonetheless, the third wave will not arrive in its full glory until the advent of *COM+,* the much-awaited next generation of *COM.* For, although being at the very heart of *Microsoft's DNA* strategy, *MTS* is, somewhat paradoxically, destined to disappear as an independent unit of software with the release of *COM+,* which will make *MTS* and *COM* coalesce and, hence, presumably render *MTS*-style separation of *state* and *behaviour* all but ubiquitous in *Windows* programming.

1.2.27.1 What is a Transaction Processing Monitor?

Until recently, *Transaction Processing Monitors (TPMs* or *TP monitors)* were almost exclusively used in large and complex *On-Line Transaction Processing (OLTP)* systems.[2702] Classical examples of *OLTP* applications will include on-line ticket booking, banking, *ATM (Automated Teller Machine),* and stock exchange systems, which all involve tough requirements on safety, robustness, and availability, a potentially high transaction load, and a large number of clients, possibly widely dispersed geographically and, possibly, working against multiple databases. Many such systems are mainframe-based and use one of *IBM's* TP monitors *CICS (Customer Information Control System)* and *IMS (Information Management System)* or *Tandem's Pathway,* but a growing number of three-tier client/server systems make use of *distributed transaction processing monitors (DTP monitors* or *DTPMs)* such as *BEA's Tuxedo, NCR's TopEnd* (recently acquired by *BEA),* the client/server version of *CICS,* or *IBM/Transarc's Encina* in *UNIX, Windows NT,* and other non-mainframe environments.

The use of *TPMs* is sometimes referred to as *TP-Heavy* in contrast to the *TP-Lite* style of transaction handling provided by many database management systems. *TPMs* usually perform two important tasks. Unsur-

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2694 [GLJ97] provides an extensive tutorial of *MTS 2.0,* and other rather comprehensive treatments are found in [Sess98a] p. 249 et seqq., [Kirt99] p. 67 et seqq., [EE98a] p. 479 et seqq., [EE98b] p. 301 et seqq., [HS98b] p. 73 et seqq., [Patt98b] p. 177 et seqq., [Pinn98] p. 169 et seqq., [Grim97] p. 511 et seqq., [BN97] p. 178 et seqq., and [Lhot97] p. 505 et seqq. [Dolg98b], [Chap97c], and [Chap98a] provide magazine-article surveys of *MTS.* In addition to the *Platform SDK MTS* documentation (available on the web at the *MSDN* web site http://msdn.microsoft.com/library/default.htm), important *Microsoft*-provided materials on *MTS* include [Micr98ϕ-χ]. [BS98] cites some interesting *MTS*-related market surveys and prognostications from the *Gartner Group* and the *Standish Group.* [Sess98b], [Chap98d], [Micr98l], [Viza98], and [Lint99] pits *MTS* (or *COM,* or *DNA)* against *Enterprise JavaBeans* (and *CORBA).*

2695 [Box98b]

2696 [Mele98]

2697 [Utzs98]

2698 [Sess97b], [Sess98e].

2699 [Dick98] p. 31

2700 Ibid.

2701 [Box98b] and [Box98a] p. 377 et seqq.

2702 See [OHE96a] p. 257 et seqq. The standard work on transaction handling is [GR93], whereas [BN97] provides a somewhat less daunting exposition of the subject. [BK99] provides a guide to the object monitor product market.

prisingly, one task is *transaction management,* i.e. the handling of transactions, possibly across multiple databases resident on different servers. The other major task is *process management,* which is a concept that soon will be explained.

A *transaction* is a group of operations – typically pertaining to a database – that will either be *committed* or *rolled back* in the lump. If any operation fails, all operations will be undone; otherwise, they will all be made persistent. In source code, a transaction is started by a programmer-issued command named *begin_transaction* or something similar and is brought to an end with a *commit* or *abort* command. The *commit* command implies that all changes made to databases and other *resource managers* since the issuance of *begin_transaction* will be made persistent, whereas the *abort* command implies that they will instead be rolled back. Transactions should comply with the well-known *ACID (Atomicity, Consistency, Isolation, Durability)* requirements: *Atomicity* implies that transactions should be indivisible, *consistency* that they should leave the system in a consistent state, *isolation* that each transaction should be entirely isolated from other concurrently executing transactions, and *durability* that their effects should be durable after *commit.*[2703]

Two-phase commit is a protocol – standardised by *ISO* as *Open Systems Interconnect-Transaction Processing Format and Protocol (OSI-TP FAP* or *OSI-TP* for short) – that avouches the integrity of updates spanning multiple resource managers, which typically will be *DBMSs* or *TPMs.* This happens in two steps: Firstly, the *transaction manager* (or *commit manager)* sends a *prepare-to-commit* to all subordinate *resource managers,* which, if necessary, may forward the *prepare-to-commit* command recursively to their own subordinates. The *resource managers* reply by either a *ready-to-commit* or a *refuse* response. If no *refuse* is received, the *transaction manager* sends a *commit* command to all *resource managers,* which thereupon make the changes accumulated during the transaction persistent. If a *refuse* is received from any of the resource managers, a *rollback* command is issued by the *transaction manager* and the *resource managers* discard the accumulated changes instead. This scheme is reasonably robust, although not altogether waterproof.[2704] *X/Open* has defined the *XA API,* which implements the *OSI-TP* two-phase commit protocol. Many popular heavy-duty *DBMSs* (e.g. *Oracle, Informix, DB/2,* and *Sybase)* and *TPMs* (e.g. *BEA Tuxedo, BEA/NCR TopEnd, IBM/Transarc Encina,* and *SNI OpenUTM)* support the *XA* standard. Another prospective standard is the *Transaction Internet Protocol (TIP),* which is an *Internet Engineering Task Force* draft for a *two-phase commit* scheme suitable for use on the *Internet.*[2705]

In addition to *transaction management*, TP monitors usually provide for *process management,* which involves various features conducive to *scalability,* such as pooling of server processes/threads and database connections, mapping and prioritising of client requests to these pooled resources, and monitoring and balancing of load, for example by starting more threads or distributing load across servers and/or processors. The act of "multiplexing" or "funnelling" a very large number of users to a considerably smaller amount of server resources shared through pooling is actually a principal motif for the use of transaction monitors.[2706] In sum, the benefits that will result from the use of *TP-Heavy* (as compared to *TP-Lite* or no transaction management at all) include enhanced robustness, scalability and availability, better protection of data, reduced demand of critical resources such as memory, threads, and database connections, and, possibly, considerably simplified development. For systems with a very large number – say several hundreds or even thousands or tens of thousands[2707] – of simultaneous users, transaction monitors are widely held to be a *sine qua non,* although they may be used to good advantage also for smaller-sized client/server systems.

2703 There are some variants of the ordinary transaction-handling scheme: *Nested transactions* support the use of subtransactions. A parent transaction may not commit, until all its subtransactions have committed, and the subtransactional changes will not be made persistent, until the parent transaction has committed. This scheme is not in wide use, although the *Encina TPM* supports it. *Chained transactions,* which may be useful in e.g. workflow systems, let one transaction start another transaction immediately after it has commited without loss of state data, locks, and other resources held at the transaction boundary. See [OHE96a] p. 270 et seqq. and [BN97] p. 317 et seqq. and p. 54.

2704 Cf. [OHE96a] p. 266.

2705 See [LEK98].

2706 Cf. [Cobb98b]

2707 [OHE96a] p. 317 mentions a *Tandem Pathway* application that entertains more than 17.000 concurrent clients. Popular web sites will experience peaks with extremely high numbers of "simultaneous" users. For instance, [Digi98b], a *Digital* press release issued in May of 1998, reports the number of daily searches made at the *AltaVista* site to be 36 million and the number of users per month to be 21 million.

1.2.27.2 Distributed Objects and Transactions

Currently, there is a strong trend to combine distributed object technology with transaction monitors, as witnessed by products such as *BEA's WebLogic Enterprise* (previously called *M3* and originally code-named *Iceberg)*[2708], *IBM's* mysterious *ComponentBroker,* which has been hovering around in an arcane limbo between beta version and regular release for considerable time now, *Inprise's Integrated Transaction Service (ITS),* which is based on transaction technology jointly developed by *Inprise/Visigenic* and *Hitachi,* and *IONA's Orbix OTM (Object Transaction Manager),* which uses transaction processing technology from the *IBM* subsidiary *Transarc.*[2709] Such products are variously referred to as *object transaction servers (OTSs), object transaction monitors (OTMs),* or just *object monitors.* Some analysts make a distinction between *object transaction monitors (OTMs),* which are – in most cases *CORBA*-based – object request brokers extended with a transaction service such as *OMG's OTS (Object Transaction Service)* –, and more sophisticated *object managers,* which provide a more integrated, component-based transaction environment.[2710] *Orbix OTM* and *Inprise ITS* belong to the former group, whereas *Microsoft's Transaction Server, BEA's WebLogic Enterprise,* and *IBM's ComponentBroker* possibly qualify for the latter. Some *application servers* may come very close to *OTMs/object managers,* but generally have a very clear-cut *Java* and web orientation, whereas *OTMs* and *object managers* are not so distinctly oriented towards the web and a single language, but are more general in scope. These rather subtle differences may wane as time goes on, and a new category of *universal middleware,* encompassing transaction monitoring, object brokering, messaging, web server functionality, and various other services, may eventually result.[2711]

Object-oriented or component-oriented transaction software may be based on *COM, CORBA OTS,* or *Enterprise JavaBeans.* Besides *MTS,* only *Sybase's Jaguar Component Transaction Server (CTS)* currently supports server-side *COM* components; this very flexible product actually also supports *CORBA* objects and will support *Enterprise JavaBeans* as well.[2712] In addition, *Informix* has announced that it will support the execution of *COM* components in the *Informix Dynamic Server* with the *Universal Data Option.*[2713] Most application servers support or will support *Enterprise JavaBeans,* whereas products such as *BEA's WebLogic Enterprise, IBM ComponentBroker, Orbix OTM* and *Inprise ITS* are *CORBA*-based, although they may be expected to add support for *Enterprise JavaBeans* in the future. *Microsoft* will most likely support neither *Enterprise JavaBeans,* nor *CORBA OTS,* although *Microsoft* does support various interoperability initiatives currently in the offing.[2714]

1.2.27.3 OLE Transactions and the Distributed Transaction Coordinator

Microsoft's transaction technology rests on three pillars: *OLE Transactions,* the *Distributed Transaction Coordinator (DTC),* and the *Microsoft Transaction Server (MTS). OLE Transactions* specifies *COM* interfaces for transaction management, which functionally correspond to the *XA API,* as well as a number of *COM* objects that are needed in transactional scenarios.[2715]

Microsoft's transaction manager *DTC*, which originally was released together with *Microsoft SQL Server 6.5* before the introduction of *MTS* and now is considered part of the *Windows NT* operating system, implements the *OLE Transactions COM* objects and also factory objects for some of the *OLE Transactions* object classes. Although *OLE Transactions* is not directly compatible with the *XA* protocol, it is possible to have an *OLE Transaction* resource manager, such as *SQL Server,* participate in a transaction controlled by an *XA* transaction

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2708 [Gutt98]

2709 See [Gill98e] and [Klay98].

2710 See [Gill98c]. [Tayl98a] p. 106 et seqq. uses the term *object engine* to designate an object database, which does not only store objects, but executes them as well.

2711 [Gill98c]

2712 [Ande98]

2713 [Info99]

2714 [Micr98ψ-ω]

2715 Currently only *flat transactions* – i.e. neither *chained,* nor *nested transactions* – are supported. The *OLE Transaction* objects are the *MS DTC proxy core object,* the *Transaction,* the *Transaction Options,* the *Export,* the *Enlistment,* the *Voter,* and the *Resource Manager object.*

manager by using *DTC* together with a special *XA mapper,* which in this case acts as a bridge, making the *OLE Transaction*-based resource manager appear as an *XA* one to the *XA* transaction manager.

Additionally, *MTS* uses *DTC* as its transaction management infrastructure. In fact, the application programmer usually does not need to care about *OLE Transactions* and *DTC* at all, but will rather take advantage of the much simplified transaction facilities provided by *MTS*. Consequently, *MTS* rather than *OLE Transactions* or *DTC* will be in focus for the rest of this section.

1.2.27.4 MTS Components and MTS Objects

What sets *MTS* apart from the current generation of *TPMs* is above all its innovative use of *COM* components as transactional building blocks, for which *MTS* acts as a container and run-time environment. In the documentation of *MTS, COM* components intended for use in *MTS* are variously referred to as *components, MTS components,* or *application components,* whereas an instance of such a component is called an *MTS object*. An application or *MTS* object that uses an *MTS* object is called a *client,* and if the client executes separately from the *MTS* environment, it is called a *base client*. In many cases, the *base client* provides the user interface of an application and passes on all data access requests to *MTS components*. An *Active Server Page (ASP)* script may also play the rôle of a *base client*. In the first place, *MTS* will be used to build scalable three-tiered applications and web applications that need to access a database.

Frequently, *MTS components* will implement simple data access and update logic and perhaps some business logic as well. There are also various technical requirements such components must comply with: They should be implemented as *in-process servers* – i.e. in a DLL, not in an EXE file –, they must implement the function *DllGetClassObject* and a class factory (the *IClassFactory* interface), they must be accompanied by a type library, they must support self-registration and implement the function *DllRegisterServer,* they must only export interfaces that support standard marshalling, etc. Additionally, for a component to be used transactionally, its methods must indicate success or failure at the completion of their execution by calling the *IObjectContext::SetComplete* or *IObjectContext::SetAbort* methods. *MTS* components may be implemented in any *COM* capable language, including *Visual C++, Visual J++*[2716]*,* and *Visual Basic*[2717]*,* and may be used by *base clients* written in such languages or in *COM* capable script languages.

Jointly, *MTS* and *COM* also provide an *object broker,* which supports *location transparency* for components. A component may be executed either on the user's computer as a *local component* or on a remote computer as a *remote component*. Furthermore, a *local component* may be loaded either into the process of the client application as an *in-process component* or into a separate *server process* dedicated to the hosting of *out-of-process components* – such a *surrogate process* will also provide isolation from faults in the client process and other server processes. Remote components are always loaded in a server process on the host machine.

1.2.27.5 The Architecture of MTS

The *MTS* run-time environment and services are implemented by the *MTS Executive*. The *MTS Executive* is a *DLL (mtxex.dll),* which is loaded into every process that entertains *MTS components*. Commonly, this process will be an *MTS surrogate process (mts.exe),* but it may as well be a client programme. The *MTS Executive* relies upon *resource managers* and *resource dispensers* to manage durable and non-durable state, respectively.

In most cases, a *resource manager* is a relational database management system, such as *Microsoft SQL Server*, although, in principle, it may be any kind of persistency mechanism, including a non-relational *DBMS,* a file system, a document storage system, or a message queue. It should be noted that although *MTS* will only run on *Windows NT, Windows 95,* and *Windows 98,* resource managers may run on any operating system, including *UNIX* and *MVS*. The client library – typically an *ODBC* driver – of an *MTS resource manager* must, however, support the *OLE Transactions* protocol in order to be able to participate in *MTS* transactions, since *MTS*

2716 [Hans98]

2717 See [Hoag98] and [Patt98a].

delegates the management of transactions to the *Distributed Transaction Coordinator (DTC),* which uses *OLE Transactions* as its native two-phase commit protocol.[2718]

Resource dispensers are *DLLs* used to manage shared, non-durable data, such as database and network connections, threads, objects, and memory blocks.[2719] *MTS* currently supplies two *resource dispensers:* the *ODBC resource dispenser* (included in the *ODBC 3.0 Driver Manager),* which is in charge of the *ODBC* database connection pool, and the *Shared Property Manager,* which supports synchronised access to shared global variables within the current process.[2720] *MTS components* use these two *resource dispensers* to allocate and release database connections and shared data. It should be noted that database connections are usually a scarce resource and should be held by an *MTS object* only for the shortest possible interval.[2721] Some resource dispensers, including the *ODBC resource dispenser,* automatically enlist the resources they manage in transactions.[2722]

MTS is closely integrated with *Microsoft's* other enterprise technologies, such as *MSMQ, IIS,* and *MSCS*. Asynchronous *MSMQ* messages may, for example, be included in transactions, *MTS* components can be used from an *IIS Active Server Page,* and *MSCS* fail-over functionality may be taken advantage of to set up a high-availability *MTS* configuration. Although *MTS* is not expected to be ported to non-*Windows* environments, *Microsoft* has gone far to provide interoperability with non-*Microsoft* systems and products frequently used in enterprise environments. Through *OLE Transactions* compliant *ODBC* drivers and other software, it is – or will become – possible to use most important relational database systems together with *MTS,* irrespective of which operating system is used on the database server. Additionally, interoperability with *IBM* mainframe systems is catered for through the *SNA Server*. Work is going on to integrate *MTS* with other transaction monitors through the *Transaction Internet Protocol (TIP)* and currently targets *IONA's OTM (Object Transaction Monitor)* and *Digital's ACMS (Application Control and Management System).*[2723] Interestingly, this effort will result in interoperability between *MTS* components and the *CORBA* objects of the *Orbix OTM*.

1.2.27.6 Process Management

Similarly to most transaction processing monitors, *MTS* provides support for features related both to *process management* and to *transaction management*. The *process management* features currently implemented are:

[2718] Many *resource managers,* including important *RDBMSs* such as *Oracle, Informix* and *DB2,* do not natively support *OLE Transactions,* but rather the *XA* two-phase commit protocol recommended by *X/Open*. However, an *OLE Transactions-to-XA mapper* included in the *MTS SDK* makes it possible to add *OLE Transactions* emulation to an *XA*-capable resource manager rather easily. Mapping support is typically included in the *ODBC* driver for the *resource manager*. For example, *Microsoft* supplies such mapping *ODBC* drivers for *DB2* and *Oracle,* and mapping drivers are forthcoming for *Informix, OpenIngres, Sybase,* and *Tandem NonStop SQL*. Additionally, by using the *COM Transaction Integrator (COMTI,* previously known as *Cedar)* and *Microsoft's SNA Server,* it will be possible to have *MTS* co-ordinate *CICS* and *IMS* transaction programmes as well. See [Mill98b] for more details.

[2719] Frequently, a *resource dispenser* is used to handle connections to a *resource manager*. A pivotal rôle in *Microsoft's* resource dispenser architecture is played by the *Resource Dispenser Manager (DispMan),* which manages – i.e. loads and unloads – the different *resource dispensers,* interoperates with the *MTS Executive,* and provides administrative support for the resource pooling done by the dispensers. When an object is removed, *DispMan* automatically reclaims extant resources, and it sees to it that transactional resources handed out to objects are enlisted in the current transaction of the object. Additionally, it uses the *Inventory Statistics Manager* to check, whether the number of pooled resources needs to be adjusted, and may ask a *resource dispenser* to create or delete resources accordingly. It is possible for third parties to use these facilities, which are part of the *MTS SDK,* to build custom *resource dispensers*.

[2720] *Microsoft* also provides other resource dispensers for use with *MTS* components: *OLE DB* contains a resource dispenser for database connections, *MSMQ* another one for *MSMQ* queues, and *COMTI* yet another one for *SNA* connections to *CICS* and *IMS*. [Cund98] treats of the construction of custom resource dispensers.

[2721] Connections are allocated from the pool through a *SQLConnect* or *SQLDriverConnect* call and returned to the pool through a call of *SQLDisconnect*. These calls are typically not explicitly issued by the application programmer, but are made inside some database *API* such as *ADO*. The connection pool increases and decreases dynamically due to the number of connection requests; actually, its size cannot currently be directly manipulated at all.

[2722] See [Chap98a].

[2723] See [Micr98ψ-ω] and [McKa98a-b]

- partitioning of components into *application packages* that may be distributed over different server machines *(static load balancing)*
- *thread pooling* facilitating reuse and multiplexing of threads between *activities*
- *database connection pooling* handled by the *ODBC resource dispenser* as just described
- *just-in-time (JIT)* object activation and *as-soon-as-possible (ASAP)* object deactivation

More details on these facilities will follow below. Process management features that are planned, but as yet not implemented include:

- dynamic distribution of client requests among servers *(dynamic load balancing)*
- *object pooling/recycling*

Presently, the scalability of *MTS* is not altogether top-notch as compared to that of some of the more mature transaction processing systems.[2724] This is partly a consequence of the lack of support for various advanced features in the current version of *MTS,* including dynamic load balancing, object pooling and recycling, and direct tuning control of the connection pool mechanism. The fact that *Windows NT* cannot currently be used on the most powerful hardware and has only rather limited multiprocessor support, also conduces to this lack of scalability.[2725] These issues are likely to deliquesce, as the multiprocessor and clustering support in *Windows NT* evolves and more powerful (multiprocessor) *NT* hardware hits the market, and will rather mirror a lack of maturity than any congenital insufficiency with *Windows NT*.

1.2.27.7 Transaction Management

MTS relies on *DTC* for the management of transactions, but is able to expose a much simplified transaction management interface as compared to that of *OLE Transactions*. Most importantly, *MTS* supports *automatic transactions,* which obviate the need for explicit hand-coded "begin transaction", "commit", and "abort" statements in a component by making transaction support a configuration option for the component. An *MTS* transaction may span multiple databases on different machines and may also include transactional access of *MSMQ* message queues and of mainframe databases. *MTS* supports *declarative transactions,* which is to say that the *transaction attribute* (or *transaction support level)* of a component is declaratively set by a programmer in a type library[2726] or by an administrator in *MTS Explorer*. The valid *transaction support levels* are:

- The component *requires a transaction*. If its creator is transactional, the component uses the creator's transaction; otherwise, a new transaction is initiated. This is a particularly good choice if the component updates more than a single "transactional resource" such as a database record.
- The component *requires a new transaction* – a new transaction is created heedless of the status of the creator.
- The component *supports transactions*. If its creator is transactional, the component uses the creator's transaction, otherwise it is not run transactionally. This may be a good choice for components that only update a single "transactional resource" and do not create other

[2724] In [Viza98], Michael Gross, a *COM* product manager avouches the existence of *MTS* applications with more than 2500 users, and [John98a] reports that *Microsoft's TerraServer* site http://www.terraserver.com – a terabyte-sized *SQL Server 7.0* database containing images of the *Earth* – is capable of handling 10000 concurrent users (the transaction monitor used, if any, is not stated). Recent *TPC* performance test results may be checked out at http://www.tpc.org. At the time of writing, *UNIX* systems hold the top *TPC-C* results, whereas *NT* systems hold the top price/performance results. It should be noted that the best *NT* results have been achieved with *BEA's* mature transaction processing monitor *Tuxedo* rather than with *MTS*.

[2725] However, *Compaq/Digital* provides some very powerful models of its *AlphaServer* in *NT* configurations with up to 14 *Alpha* processors. Furthermore, [Coll98a] provides evidence that very powerful *Windows NT*-based clusters can be built also from comparatively mundane *Pentium* hardware.

[2726] This is done by prefixing the *coclass* declaration in the *COM IDL* file with one of the four *transaction attributes* [TRANSACTION_REQUIRED], [TRANSACTION_REQUIRES_NEW], [TRANSACTION_SUPPORTED], and [TRANSACTION_NOT_SUPPORTED].

components, since such a component will only need to be run in a transaction, in case another component belonging to the same *activity*[2727] also accesses a transactional resource.

- The component *does not support transactions* – the component should not be run transactionally.

An *MTS object* is either *transactional* or *non-transactional.* Instances of components that require a (new) transaction are always *transactional,* whereas instances of components that do not support transactions are always *non-transactional.* An instance of a component that supports transactions is *transactional* if the object from which it was created is; otherwise, it is *non-transactional.*

When a method of an *MTS object* that requires a transaction is called, a new transaction will in most cases be initiated automatically, unless the caller is already part of an ongoing transaction.[2728] If the caller is part of a transaction, a component that requires or supports transactions will instead participate in its transaction. Hence, components may be easily combined under the auspices of a single transaction context: If a transactional component creates or calls another component that requires or supports transactions, they will both share the same transaction context, and any updates they make to the database will be committed or rolled back as a unit, when the parent component commits or aborts. The transaction commits or aborts implicitly, as the method call that initiated the transaction returns, provided that the component of this initiating method has signalled that its work is complete by calling *IObjectContext::SetComplete* or *IObjectContext::SetAbort.* Alternatively, the component may call *IObjectContext::DisableCommit* or *IObjectContext::EnableCommit* in order to cause the transaction to abort or commit when all references to the component have been released. A call of *DisableCommit* may later be undone by a call of *EnableCommit* on the same context object. If none of these methods *(SetComplete, SetAbort, DisableCommit* or *EnableCommit)* have been called, the transaction will commit, when all references to the object have been released. A transaction that has not committed or aborted within a configurable timeout period (by default 60 seconds) will abort automatically.

In contrast, if the created component is configured to require a new transaction, it will maintain its own transaction context and be committed or aborted independently of its parent.[2729] It is also possible for a client application to create a higher-level transaction context that will embrace the components used by it, although this is not the recommended way of doing things in *MTS.*[2730] Whenever a transaction commits or aborts, all transactional objects involved will be deactivated and lose their state – in case they would not, there would be a great risk that they would sooner or later hold invalid data.[2731] This is the reason why *transactional MTS objects* should be "stateless" by design. *Non-transactional objects* may hold state across method calls.[2732]

[2727] The *activity* concept will be explained below on p. 587.

[2728] However, a few method calls do not cause a transaction to be initiated, including *IUnknown::QueryInterface, IUnknown::AddRef, IUnknown::Release, IDispatch::GetIdsOfNames,* and the *ISupportErrorInfo* methods. Except for these, a call of a method belonging to a transactional component will imply that a transaction is initiated – regardless of whether it is needed or not. In *COM+,* a transaction will only be initiated when it is actually needed due to, for example, a database access *(just-in-time transactioning).*

[2729] Currently, *MTS,* just as *DTC,* supports neither *nested transactions,* nor *chained* ones.

[2730] Such a transaction is started by a base client through the creation of a *transaction context object,* which implements the *ITransactionContextEx COM* interface, and is concluded by calling the *Commit* or *Abort* method on this object. Additionally, an *MTS component* that has been marked as not supporting transactions may make its own *OLE Transactions* calls. Thus, *MTS* supports the three schemes of demarcating the boundaries of a transaction stipulated in the *Enterprise JavaBeans* specification – viz. *client-managed, container-managed,* and *bean-managed demarcation* –, although *container-managed demarcation* is the recommended course in *MTS.* See [Micr98l] and [MH98].

[2731] See [Box98c], [Patt98a], and [Ewal99], who all emphasise that the requirement for statelessness derives from the semantics of transactions rather than from scalability concerns, as often purported. Cf. also [BBES99] p 199 et seq. In contrast, [Sess98a] p. 249 et seqq., [Sess98c], [GLJ97] p. 164 et seqq., [Kirt99] p. 81 et seqq., and [Chap98a] associate statelessness with scalability. At any rate, statelessness will obviate some programming habits that definitely do not make for scalability, such as invoking a remote object repeatedly or holding on to database connections, record locks, and server-side threads for extended periods of time. For a general discussion of the handling of state in *MTS*-based applications, see also [Krou98].

[2732] In contrast, the *Enterprise JavaBeans* specification [MH98] differentiates two types of components, *session* and *entity beans. Session beans* are much like *MTS components* and may be either stateless or stateful. An *entity bean* represents specific data – typically a record – in a database, and, unlike a *Session bean,* it must have a unique key, use transactions, and support multiple simultaneous users. An *entity* bean may either load and save its data itself *(bean-managed persistence)* or delegate these tasks to its container *(container-managed persistence),* and it should survive a crash. It seems that an *EJB* container capable of hoarding *entity beans* and supporting *container-managed persistence* amounts to nothing less

When *MTS* instantiates an object, it also creates a *context object,* which maintains data about the transaction, thread (activity), and security of the object created. As we have already seen, the context object is accessed through the *IObjectContext* interface. Additionally, a *context wrapper* maintains references both to the object proper and to its context object, and a *class factory wrapper* keeps a reference to the class factory of the component. A *transactional object* will be deactivated and removed from memory by *MTS* through *as-soon-as-possible (ASAP) deactivation,* whenever its current transaction commits or aborts (or a new transaction involving this object is started[2733]), whereas a *non-transactional object* will only be deactivated, when any of its methods return after having called *IObjectContext::SetComplete* or *IObjectContext::SetAbort.*[2734] The client will still keep a reference to the deactivated object, and, as soon as it calls a method on the object, this will be re-activated by *just-in-time (JIT) activation,* although the object state will not be restored upon activation, since state cannot be safely maintained across transactional boundaries, as just explained. Re-activation is easy, because *MTS* keeps the context wrapper and context object in memory as well as the class factory and class factory wrapper, as long as there are extant references to the deactivated object. Although not currently supported, *object pooling* and *object recycling* are features planned to be included in *MTS* as optimisations.[2735] *Object pooling* will make it possible to create a pool of pre-loaded objects, whereas *object recycling* lets such a pool object be reused by any client, as soon as it has been deactivated. Currently, objects are simply deleted, when they are deactivated, and created again through a call to the class factory, when they are activated.[2736]

MTS works its wonders through *interception* of the method calls on the *MTS objects*. All method invocations are *intercepted* by the aforementioned *context wrapper,* which performs various crucial tasks both before and after the call proper. Before the call, it ensures that there is no concurrent access to the object and, in case the object is transactional, that there is an active transaction, activates the object (if necessary), and performs security checks. After the call, the *context wrapper* checks the outcome of the transaction and sets the return value accordingly, deactivates the object (if possible), and releases various resources allocated during the call. It should be noted that for interception to work properly, an interface pointer must never be passed out from an *MTS object* without first having been converted to a *safe reference,* which is done through a call of the *SafeRef API* function.[2737]

1.2.27.8 The MTS Programming Model – Basic Concepts

The *APIs* of *MTS* are comparatively simple – in many cases, the programmer only needs to know about the *COM* interface *IObjectContext,* although he should also implement the very straightforward *IObjectControl* interface in order to prepare his component for the future blessings of *object pooling.* Only occasionally will he need to use *ISharedProperty, ISharedPropertyGroup,* or *ISharedPropertyGroupManager,* and he had better shun the *ITransactionContextEx* interface altogether. Still, the programming model used when building *MTS components* may estrange many programmers and in particular those skilled in object-oriented programming, since it lets

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than a full-blown database management system – possibly, an object-oriented one at that. Support for *session beans* is mandatory for *Enterprise JavaBeans* compliant products, whereas *entity beans* are optional in the first version of *EJB,* but will become mandatory in *EJB 2.0.*

2733 [Box98c]

2734 This implies that *non-transactional objects* may be used as "stateful objects", maintaining state across method calls, as long as *IObjectContext::SetComplete* or *IObjectContext::SetAbort* are not invoked inside their methods. Cf. [BBES99] p. 195 et seqq.

2735 Only *managed objects,* i.e. objects implementing the *IObjectControl* interface, will be capable of pooling. The *IObjectControl* interface comprises three methods: *Activate, Deactivate,* and *CanBePooled. CanBePooled* will be called immediately before pooling. If FALSE is returned, the object will not be pooled by *MTS*. *Activate* and *Deactivate* may be used for initialisation and clean-up.

2736 According to [Box98c], *object pooling* and *recycling* are not done in the current version of *MTS,* because presently each *MTS object* is a fixture of a certain *STA (Single-Threaded Apartment* – cf. below p. 588) thread. Thus, it would only be possible to recycle each object within its own thread – certainly, a rather useless kind of optimisation! Not until the *rental* threading model is supported by *MTS,* will object pooling and recycling become feasible. *Object pooling* and *recycling* are sometimes alleged to enhance scalability greatly by the efficient use of memory, but for *MTS objects* that are not extraordinarily large-grained the per-object memory demands of the stub, context wrapper, context object, etc. will regularly outvie those of the object itself by far, thereby reducing the importance of this memory re-use considerably. Rather, the importance of object pooling and recycling will be that they make creation and activation of frequently used *MTS objects* faster.

2737 Interface pointers returned from *CoCreateInstance, ITransactionContext::CreateInstance, IObjectContext::CreateInstance* or passed through *IUnknown::QueryInterface* are always valid *safe references,* whereas interface pointers passed as parameters or return values through other methods must be converted to *safe references*. By the way, passing out references to objects created inside a transaction may cause the transaction not to be committed. For a discussion of this quirk and various other kinks and catches of *MTS* programming, see [BBES99] p. 183 et seqq.

go of one of the most cherished habits of object-oriented programming, to wit the inclusion of state in objects.

As pointed out in the previous section, every *MTS object* is associated with a *context object,* which is created together with the *MTS object* and holds information about the transaction context of the object, its security settings, the *activity* to which it belongs as well as which client created it. In order to retrieve a reference to the *object context,* most methods of an *MTS component* will start with a call of the *API* function *GetObjectContext*. The *object context* implements the *IObjectContext* interface, the most important methods of which will be *CreateInstance, SetComplete,* and *SetAbort*. The *IObjectContext::CreateInstance* method should be used in preference to the *CoCreateInstance* (or *CreateObject* in *Visual Basic)* when creating *MTS objects* inside an *MTS object* so as to propagate the transaction context, the activity, and the security settings to the object context of the new *MTS object* properly.[2738] At the end of each method, either *IObjectContext::SetComplete* or *IObjectContext::SetAbort* should be called in order to signal that all updates made in the object should be commited or aborted and that *MTS* may now deactivate the object and thereby discard any instance data present in the object. This implies that the object cannot maintain any state between method invocations (or rather across transaction boundaries), i.e. that it must be *stateless.*[2739]

The *Visual Basic* code below illustrates an idiom commonly encountered in the methods of *MTS objects:*

```
Dim ctxObj As ObjectContext
Set ctxObj=GetObjectContext()

'Read any state data needed from database

'Do something
'Note that MTS components should be allocated thus:
'Set anMTSObject=ctxObj.CreateInstance("Cock.Bull")

'Save updated state if necessary

if (success)
   ctxObj.SetComplete
else
   ctxObj.SetAbort
```

Although *MTS* supports multithreading, it shields the programmer almost entirely from getting embroiled in the many complications and involutions of multitasking. As a backgrounder, we will now give a brief account of how *COM* multithreading works.

1.2.27.9 Excursion: Multithreading in COM

COM currently supports three different *threading models: Single threading* (also called the *no threading model), apartment threading*, and *free threading.*[2740] Additionally, a new model called *rental threading* or the *thread-neutral apartment model* will be introduced in *COM+*. Both a *COM* client and a *COM* server have a threading model of its own, and in case these are not the same, *COM* will make it appear to each of the two parties as though the other one played by the same rules.[2741] When *COM* is combined with multithreading, the client process is

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[2738] Only *base clients* should use *CoCreateInstance* or *CoCreateInstanceEx* to create *MTS* objects. Additionally, an *MTS object* may not be part of an aggregate of objects, although it may itself be implemented as an aggregate of *COM* objects. The requirement to use *IObjectContext::CreateInstance* will disappear in *COM+*. See [Kirt99] p. 385.

[2739] Although not commendable, it is – at least in principle – possible to use *stateful* components with *MTS,* if *IObjectContext::EnableCommit:* and *IObjectContext::DisableCommit:* are called instead of *IObjectContext::SetComplete* or *IObjectContext::SetAbort.* Because of the transaction timeout, this will not be a very reliable technique unless the timeout is set to something very large. In order to maintain state between method invocations, it would be a better idea to use non-transactional objects or to take advantage of the *shared property manager*.

[2740] See [HK97], [Smit98], [Box98a] p. 199 et seqq., [Micr98m] p. 26 et seqq., [EE98a] p. 127 et seqq., [Patt98b] p. 137 et seqq., [Grim97] p. 481 et seqq., and [Plat98] p. 421 et seqq. The *apartment model* first appeared in *Windows95* and *Windows NT 3.51,* whereas *free threading* was introduced in *Windows NT 4.0* in 1996 and has since gained support also in *Windows95* (through the *DCOM* service pack) and *Windows98.*

[2741] Clients and out-of-process servers specify the threading model when initialising *COM* through a call of *CoInitializeEx,* whereas in-process servers specify it by a registry entry. The default value is single threading.

divided into *apartments,* each of which entertains its own *COM library* and its own set-up of *COM* objects. As we shall soon see, there are three distinct types of apartments, each associated with a particular threading model, viz. the *Single-Threaded Apartment (STA),* the *Multi-Threaded Apartment (MTA),* and the *Rental-Threaded Apartment (RTA).* Each *COM* object belongs to a single *apartment,* although one apartment may house any number of *COM* objects. The methods of a *COM* object may only be called directly from inside its own apartment, while cross-apartment calls will usually be marshalled through an *interthread marshaller.*[2742]

In the *apartment model,* each apartment accommodates one thread only; hence, such an apartment is called a *Single-Threaded Apartment (STA).* This thread must include a message loop, and all incoming cross-apartment calls will be queued and handled one by one in a strictly serialised manner.[2743] Within an *STA,* there will be no concurrently executing threads and no simultaneous access of data, and, thus, the programmer will not have to be concerned with synchronisation, race conditions, and suchlike.[2744] To support the apartment model, a *COM* server just has to synchronise access to global data, which in most cases will be a quick feat. Importantly, the apartment model supports re-entrancy: When a synchronous call has been made through a proxy to code residing outside the current apartment, the apartment will service any incoming requests, while the calling thread is waiting for the call to return.[2745]

In contrast, the *free threading model* lets a *COM* object be accessed simultaneously by multiple threads belonging to a *Multi-Threaded Apartment (MTA).* Although free threading will be inherently more efficient than the apartment model, which is prone to waste time on marshalling, it also implies that the programmer has to handle synchronisation explicitly and it may be less efficient than the apartment model, if, for example, it is used in a *COM* server that is accessed from a client using the apartment model.[2746] Furthermore, a process may contain both an *MTA* and one or many *STAs;* such a process is said to use a *mixed threading model.*[2747]

[2742] A cross-apartment call is made via a proxy object in the caller's apartment. The proxy marshals the call and sends it off via *ORPC (Object RPC),* which, in turn, will use a lower-level transport protocol, such as the *Windows* message loop for *STAs* or *Windows NT Local Procedure Calls (LPCs)* for *MTAs* or *RTAs.* In the *STA* case, the call will show up as a message in the message queue of the (probably hidden) window associated with the thread of the target apartment, from where it will be fed to the corresponding stub object. The stub object will then unmarshal the call data and invoke the target method. In effect, the *Windows* message queue serialises access to *STA* apartments. See [Box98a] p. 206 et seqq. [Plat98] p. 430 states that according to his own measurements a call using an interthread marshaller is 50 times slower than an ordinary method call, whereas a call requiring interprocess marshalling is 200 times slower than the non-marshalled counterpart.

Also *COM* clients and *COM* servers that use different threading models take advantage of *interthread marshalling* in order to interoperate. For example, all invocations of a single-threaded *COM* server – including object creation calls – from a multithreaded client must be made from the *main thread* of the client (i.e. the thread that first called *CoInitialize),* and, hence, calls into the server from other threads of the client will have to be marshalled by an *interthread marshaller* to the main thread, from which the actual call will then be made. [Plat98] p. 429 et seq. gives more particulars.

[2743] The fact that one and only one thread will ever be executing within an *STA* is referred to as *thread affinity.* This thread must call *CoInitialize* or *CoInitializeEx* to initialise the *COM* library and must include a message loop:

```
while (GetMessage(&msg,0,0,0))
    DispatchMessage(&msg);
```

Additionally, the methods of an object that belongs to an apartment may only be directly called from the thread in which the object was created. A call from another apartment must be marshalled through an *interthread marshaller,* i.e. a proxy/stub pair, in the manner accounted for in footnote 2742.

[2744] For all this simplicity, an unwieldy complication of the *apartment model* is that interface pointers sometimes will have to be passed between apartments in a rather convoluted way (through a stream created by *CoMarshalInterThreadInterfaceInStream* and unpacked and released by *CoGetInterfaceAndReleaseStream)* so as to make it possible for *COM* to set up an *interthread marshaller* between the apartments. If an interface pointer is passed as a parameter of a method call on an existing proxy, *COM* will create the *interthread marshaller* automatically. See [Grim97] p. 485 and [Plat98] p. 440 et seqq.

[2745] See [Box98a] p. 233 et seqq., where the mechanics of *STA* re-entrancy are detailed. By default, all incoming requests will be serviced while waiting for the call to return – not only callbacks. It is, however, possible to reject or postpone some requests by using the *CoRegisterMessageFilter API* function to register a customised *message filter* object that implements the *IMessageFilter* interface. Postponing will unfortunately be very inefficient.

[2746] Preferably, *COM* servers should support both *free threading* and the *apartment model.* A major benefit of *free threading* is that the need for interface pointer marshalling disappears within the *MTA.*

[2747] In the mixed model, a call from the *MTA* into an *STA* will be handled as a call between two *STAs.* In contrast, a call from an *STA* into an *MTA* will be handled as a cross-process call, which is to say that it will be intercepted by a listener thread that assigns a thread from a thread cache to handle the call. If objects that support both the *apartment model* and the *free threading model* are present in more than one apartment *(STAs* or *MTA),* they may use the *free-threaded marshaller* to acquire direct cross-apartment interface pointers to each other,

In the *rental model,* more than one thread may enter an apartment known as a *Rental-Threaded Apartment (RTA),* although not at the same time.[2748] Any thread executing in an *RTA* will hold a lock on it, which is released only when the thread exits the apartment. The *rental model* makes *interthread marshalling* unnecessary, while maintaining serialisation of incoming calls just as in *STAs*. This model is required to facilitate *object pooling* and *recycling*.

1.2.27.10 The MTS Programming Model –Multithreading and Security

In general, the *MTS* programmer should not have to be concerned with multitasking and synchronisation issues at all. For instance, an *MTS component* should never create or terminate threads, and although many threads may execute simultaneously within an *MTS* process, there will not – and should not – usually be any direct interaction between these. In short, *MTS* is solely responsible for the creation and management of the threads used by *MTS components*.

In *MTS,* the *activity* concept is used to assign threads to objects. The *activity* of an object represents the entire set of *MTS objects* that take part in a chain of calls starting from a *base client*.[2749] Objects belonging to the same *activity* will execute within a single *logical thread of execution* and will thereby be exempt from the intricacies of synchronisation, although they may be distributed between processes and machines. However, the caller of a method may pass a reference to itself as an argument in the call, thereby providing a possibility for callbacks of its own methods, which consequently must be re-entrant. While a thread is blocked during an outbound call, *MTS* will use the *COM logical thread identifier* (more correctly known as a *causality id)* to sift out the callbacks from any other calls, which, of course, should be queued until the initial thread returns.[2750] It should be noted that objects belonging to the same activity, but situated on different machines, indeed may execute in parallel, in which case cross-calls between these parallel threads of execution will be blocked.[2751]

Currently, *MTS* does not support free threading, nor the rental model, but *MTS components* must be either single-threaded or apartment-threaded – they may, of course, also support both the apartment model and free threading.[2752] *MTS* maintains a pool of *STA* threads that are mapped to activities and, if necessary, may be multiplexed between activities.[2753] Although permissible, single-threaded components should be avoided. Since all instances of a single-threaded component must run in the same thread, they will be inherently

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thereby eliminating the overhead of *interthread marshalling*. See [Alla97], [EE98a] p. 152 et seqq., and [Box98a] p. 249 et seqq. A *COM* object that aggregates a *free-threaded marshaller* is called an *agile object*.

2748 This is the understanding of the rental model in [Box98a] p. 201. [Grim97] p. 530 and [GLJ97] p. 182 et seqq. provide different interpretations. [Kirt99] p. 387 calls this model the *thread-neutral apartment model,* which, hence, probably will be the official *Microsoft* designation for it. It is notable that this model does not support *thread affinity*.

2749 When an *MTS object* is created by *CoCreateInstance* (or *CreateObject* in *Visual Basic),* a new *activity* is associated with it*,* whereas objects created through the *CreateInstance* method of the object context or transaction context interface will be assigned the *activity* maintained by the context object called. According to [BBES99] p. 188 et seqq., *MTS objects* should never be shared across *activity* boundaries, as such sharing will endanger transaction integrity. This entails that a base client should not pass on a reference to an *MTS object* as an argument to a method of another *MTS object*.

2750 During an outbound *RPC* call, the calling thread will wait in an *MTS*-provided *message filter,* which is a simple *COM* object facilitating the inspection and handling of any incoming messages. The message filter implements the *COM* interface *IMessageFilter,* whose *HandleInComingCall* method is automatically called by *COM* whenever an incoming call is detected. From this method, the programmer returns a value indicative of whether the incoming call is to be accepted, rejected, or the client should retry later. The default *COM* message filter accepts all incoming calls. The arguments passed to *HandleInComingCall* include the *logical thread identifier* as well as a flag that indicates whether the call is a callback or a regular call, and, thus, it is straightforward to block calls that are not callbacks. See [Broc95] p. 301 et seqq.

2751 So http://msdn.microsoft.com/library/sdkdoc/mts20sp1/mtxpg04_5tf7.htm, the *Activity* section of the *Microsoft Transaction Server Programmer's Guide*. In contrast, [BBES99] p. 190, inculcating the rule that *MTS objects* must not be shared between threads, states that, if this is done, parallel execution may result not only when machine boundaries are crossed, but also when process boundaries are and expressly denies that the *MTS*-provided message filter uses the *logical thread id* as a shibboleth for sifting out callbacks from regular calls. If this indeed is correct, it seems to be a bug rather than a reasonable design.

2752 Since *MTS components* are implemented as in-process servers, they specify their threading model through the *ThreadingModel* registry entry, which may be set to *Apartment* or to *Both* (but not to *Free).* If no *ThreadingModel* entry is present in the registry, the single-threaded model is used. It is possible to examine the threading model of components in the *MTS Explorer*.

2753 In *MTS 2.0,* there may be up to 100 *STA* threads per server process.

inefficient and, in case they are stateful, prone to deadlocks as well. In addition, it is not possible to combine single-threaded *MTS objects* with *MTS objects* that use another threading model within one server process.[2754] Hence, *MTS components* should be designed according to the *apartment model* or so as to support both *free threading* and the *apartment model.*

In a multithreaded programme, sharing of global data across threads will necessitate some kind of programmer-controlled synchronisation, which at times may be both complex and error-prone. *MTS* attempts to remedy this through its *shared property manager,* which facilitates the sharing of global property values (of base types) between *MTS objects* by hiding the complexities of synchronisation from the programmer. There are a number of *COM* interfaces – *ISharedPropertyGroupManager, ISharedPropertyGroup,* and *ISharedProperty,* which the developer uses to create and manage groups of shared properties.

MTS also provides a role-based security scheme tightly integrated with the security mechanisms of *Windows NT* and supports both *declarative* and *programmatic security.* The former is typically taken advantage of by administrators through the *MTS Explorer* in order to specify which users and groups will have access to a particular entity (component package, component, or interface). Every method call on an *MTS* object is intercepted by the *MTS Executive* and checked for compliance with the declared security restrictions.[2755] Programmatic security is used inside components for more fine-grained controls so as to check that a user has the correct privileges (i.e. role) for a certain operation.[2756]

1.2.27.11 The MTS Explorer

The *MTS Explorer* is the administration tool used for the configuration and surveillance of *MTS* components and of the *MTS* run-time environment. *MTS Explorer* is a *Microsoft Management Console (MMC)* snap-in, which means that *MTS* administration may be done from one integrated management console shared by all *MMC* compatible products. *MTS Explorer* provides support for:

- the installation of components through drag and drop
- the configuration of component properties, such as transaction support level and security settings
- the grouping of components into *packages* for easy distribution or *process isolation* – each *package* is run in a separate process and maintains its own connection pool[2757]
- defining roles for users and user groups
- monitoring active transactions
- viewing trace messages and transaction statistics

A number of automation objects may be used to make scripts that automate the administration of components and packages. There is also support for automated configuration of clients.

1.2.28 MICROSOFT MESSAGE QUEUING SERVICES

The *Microsoft Message Queue Server (MSMQ),* originally code-named *Falcon* and also referred to as the *Microsoft Message Queuing Services,* in particular when viewed as an integrated part of the *Windows NT* or *DNA* platforms, provides another important piece in the brickwork for enterprise computing, which *Microsoft* is

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[2754] Components written in *Visual Basic 4.0* are single-threaded. From version 5.0, *Visual Basic* supports the apartment model.

[2755] Security is only enabled when *MTS* is running in a dedicated *MTS* process, not when it is used as in-process server in a client. It is possible to check whether security is enabled through a call to *IObjectContext::IsSecurityEnabled.*

[2756] The method *IObjectControl::IsCallerInRole* is used to check if the current client has been assigned a certain role.

[2757] A *server package* is run in a separate *surrogate process,* whereas a *library package* is run in the client's process – for instance an *Internet Information Server (IIS)* process.

currently erecting on the foundations of its *Windows NT* platform.[2758] *MSMQ* belongs to the category of software known as *MOM (Message-Oriented Middleware)* or rather to its subcategory *MQM (Message-Queuing Middleware).* We will now cast a glance at this still fairly obscure and sequestered product category, and, having done that, we will take a somewhat closer look at *MSMQ.*

1.2.28.1 What Is Message-Oriented Middleware?

Message-Oriented Middleware (MOM)[2759] provides support for message-based application-to-application communication, often metaphorically characterised as "e-mail for applications".[2760] The efficiency of *MOM* is generally known to be quite good, and systems with very high throughput rates exist.[2761] Additionally, typical *MOM* products support a wide range of platforms and network protocols, thereby providing a possible foundation for the loosely coupled integration of heterogeneous systems.

Simple *message passing* software generally requires a dedicated connection – sometimes referred to as a "pipe" – between sender and receiver, whereas *Message-Queuing Middleware (MQM)* products make use of *message queues* as buffers in order to support asynchronous, non-blocking, connectionless, peer-to-peer communication.[2762] It should be noted that the term *MOM* often is used somewhat laxly as a synonym of *MQM,* as pure *message passing* systems are not in very wide use. *Message queuing* makes it possible to buffer messages for later delivery *(store-and-forward messaging),* in case the recipient is currently busy or not available. Such *deferred delivery* (or *process-independent delivery)* is particularly useful when messages are sent over unreliable networks, such as the *Internet,* or transmitted from intermittently connected workstations, such as mobile computers or computers connected through telephone lines by remote access software.

The queues of *MQM* software may either be memory-based or disk-based – the choice between these alternatives is largely a trade-off between performance and resilience to system failure. In full-featured *MQM* products, the choice between persistent or non-persistent *delivery mode* is a configuration option. Each message queue has a name by which it is referenced by clients, and it may have a maximum size and a number of other properties as well. Most queues will adhere to a *FIFO* discipline, although in many products, there will be support for priority queues and, possibly, other queuing disciplines as well. Furthermore, queues may be transactional or non-transactional, local or remote, and explicit (i.e. directly accessible for programmers) or implicit (hidden from programmers).

Many applications may write to one queue, whereas mostly only one application reads from a queue, although for the sake of load balancing it may be motivated to have multiple readers, provided these readers are stateless. If messages can be typed, it will be possible for dissimilar readers to share a queue, provided

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[2758] [Micr98w] provides the technical documentation of *MSMQ.* Books wholly or largely devoted to *MSMQ* include [Dick98] and [HS98b] (in particular p. 163 et seqq. and p. 322 et seqq.). More concise accounts of *MSMQ* and its capabilities include [Micr97q], [Hous98a], [Sess98a] p. 443 et seqq., and [Pinn98] p. 217 et seqq. [Dolg98e] compares the features provided in *MSMQ* and *IBM's MQSeries.*

[2759] Another term occasionally used as a synonym for *MOM* is *Enterprise Message Technology (EMT).*

[2760] [OHE96a] p. 125 et seqq., [Klay97], [Myer98], [Dolg96], and [Dolg97] discuss message queuing in general and the requirements that message queuing products should meet, whereas [Korh97] surveys three important *MQM* products, viz. *VCOM* from *Verimation, DECmessageQ* (now *BEA MessageQ),* and *IBM's MQSeries.* Sundry materials on *MOM* and messaging in general are available at http://www.imwa.org, the web site of the *International Middleware Association (IMWA),* at http://www.bqm.org, the site of the *Business Quality Messaging Forum,* at http://www.ema.org, the site of the *Electronic Messaging Association,* at http://www.messageq.com, the *messageQ.com* site billed as "the independent voice for message queuing", and at http://www.middleware.org, the *Message Oriented Middleware Resource Center.*

[2761] See [Dick98] p. 345 et seqq.

[2762] [Klay97] calls memory-based queuing *message passing* and disk-based queuing *memory queuing,* but most authors understand *message passing* as message-based point-to-point communication between two applications without intermediary queues. Since *message passing* implies that data are pushed to the listeners as they arrive, *deferred delivery* cannot be supported by pure *message passing* products. It should be noted that *MQM* systems may be made to behave synchronously, e.g. by using an application-specific protocol where the requester immediately starts waiting for a reply when a request has been posted. Support for synchronous messaging may also be supplied by the *MQM* software natively. Likewise, inherently synchronous protocols, such as *RPC,* may be made to appear asynchronous by some creative use of multi-threading.

readers consume disjunct sets of message types.[2763] Both destructive and non-destructive reading ("peeking") may be supported. Whereas message posting usually is a non-blocking, asynchronous operation, message readers will mostly adhere to an event-driven style of programming. Consequently, a typical reader spends most of its time in a blocking read-loop waiting for a message to arrive. Upon message receipt, it performs some actions based on the contents of the message. In addition to this event-driven style, many *MOM* products support a non-blocking, polling-based reading scheme, and in some systems callbacks may be registered that are invoked automatically, when a message arrives. Callbacks make message receipt an *asynchronous* operation just like message posting, whereas both event-driven and polling-based receipt are *synchronous* reading schemes.

Posting (or *enqueuing)* and reading (or *dequeuing)* of messages are done through a simple messaging *API,* which additionally will include operations for creating and deleting queues and various other actions. Either an *MQM* client may be capable to buffer messages in a *local queue* or it may depend upon an *MQM* server to have its messages added to a *remote queue* directly. If only the latter mode of operation is supported, the *MQM* system will not be able to support intermittently disconnected clients. When a message arrives for an application that is not currently loaded, some *MQM* products may activate or *trigger* the application automatically, whereas others will only store the message in the appropriate queue.

A *message queue server* manages the queues and may also act as a more or less sophisticated *routing server* to help messages find their way to their destinations via intermediate servers. Additionally, the *message queue server* will maintain a *name/directory service* in order to map queue names to the physical locations of queues and a *client proxy service* to support the remoting of the messaging *API* to "dumb clients" incapable of local queuing. It may also support various security features, such as encryption and authentication of messages, and user authorisation. Often some kind of tool is provided for the task of administrating the queues, although some products will only support *API*-based administration.

Generally, a message will consist of a *header* holding the control information needed by the *MQM* software and a *body* of application-specific, arbitrary data. The lack of intrinsic structure of this data makes it difficult to automate data conversions (e.g. between different character sets, or integer and floating-point formats) and tends to forge the communicating parties together into a tightly knit conglomerate of application components that understand a small common set of custom messages. The degree of coupling between the components may be mitigated by wrapper and adapter technology.[2764] In particular, in case the software to be accessed is a third-party package, such as *SAP R/3,* or legacy software not amenable to architectural change, wrapper technology will have to be used. When *MQM* is used for wrapping, the wrapper will have to include a dispatch loop in which incoming messages are mapped to calls into the wrapped application. In many cases, these "calls" may be ordinary procedure or method calls, but if the application lacks an *API,* command line or screen scraper access techniques may have to be resorted to. Additionally, the wrapper should map any returned data to the format required by the client before a reply message is sent off.

A number of different messaging styles may be used:[2765]

- *one-way send-and-forget* is particularly useful for back-end inter-server integration[2766]
- *two-way request-reply* is appropriate for e.g. client/server-style front-end integration and may in some products be supplemented by support for blocking, synchronous *request-reply* messaging as well

It will be possible to realise a number of different architectures with *MQM.* The simplest will be the just mentioned, well-known *client/server* style, which may be easily implemented through request and reply queues. It is possible to build a client/server system on message queuing from the ground up, although this may be

[2763] If types are not supported by the *MQM* software, a type identifier may be included in the data part of the message and checked by readers. Some products support a number of pre-defined types of messages, such as *request, reply,* and *exception report.*

[2764] See [Digi98a].

[2765] See [Call98c-d]

[2766] This style may not entirely exclude occasional two-way interactions. For example, an exception report may be sent back to the caller if something goes awry.

more complicated than one may expect *prima facie*.[2767] In contrast, the use of messaging to propagate *business events* from one application to another is inherently one-way and is sometimes referred to as *push-style data delivery* or *fire-and-forget* message queuing. This kind of messaging may be generalised through a *hub and spoke* architecture, where applications send messages to a central *hub,* which re-distributes these to one or multiple readers *(multicast)* or, possibly, all readers *(broadcast)*. The *hub and spoke* architecture is particularly suitable for the implementation of *publish and subscribe* services. In this design, *subscribers* register interest for a certain type of message with the hub, which redistributes the messages sent to it by the *publishers* to the registered *subscribers.* In some products, interest registrations may contain conditional criteria that reference the contents of the message as well.

Some years ago, the *MOM* messaging mechanism was often pitted against *RPC (Remote Procedure Call)* in debates on middleware. *RPC* comes in two major variants, *DCE (Distributed Computing Environment) RPC* from *Open Software Foundation (OSF)* and *ONC (Open Network Computing) RPC* from *Sun,* and, in contrast to *MOM, RPC* supports a synchronous, connection-oriented model of communication between programmes and processes, largely reminiscent of a local procedure call. Compared to *RPC, MOM* has been characterised as "more reliable, more portable, and supportive of more underlying communication protocols".[2768] Today, the interest both in *RPC* and in the wide range of middleware supplied in the *DCE* platform[2769] seems to be on the decline, whereas distributed object technology, which may be understood as the object-oriented variant of *RPC,* has loomed up as the main alternative to *MOM.* It is, for example, possible to create distributed object wrappers of legacy software, although this will in most cases be much more complex a task than using *MOM*-based wrappers. Additionally, distributed object technology is known to require considerably more training of personnel than the rather simplistic *MOM* products. The imminent inclusion of asynchronous messaging capabilities into both *CORBA* and *COM+* will undoubtedly change the marketplace and may be understood as a step towards the *universal middleware* expected to one day replace all of today's specialised middleware categories.

Currently, the *MOM* business is expanding rapidly[2770] by virtue of its usefulness within a number of increasingly important domains:

[2767] See [Dolg96]. *MQ3T (MQSeries Three Tier),* a demised member of *IBM's MQSeries* family, aimed at facilitating the construction of *MQM*-based, event-driven (or rather message-driven) 3-tier client/server systems. In *MQ3T,* applications are regarded as large-grained *objects,* which communicate through *messages*. Thus, *MQ3T* provides a client/server infrastructure somewhat reminiscent of that of *Newi,* although, in contrast to *Newi, MQ3T* is not object-oriented, but object-based and, hence, lacks support for inheritance and polymorphism. When a message is received by an application, a *rule* associated with the message may be satisfied, in which case the *MQ3T* run-time calls at least one *method,* i.e. a procedure in the *object*. Each message must be associated with one or more rules, and rules may include conditional expressions that take instance state, timing considerations, etc. into account. Using a special *Class Definition Language (CDL),* the designer documents the class design in *class source files,* which are compiled by a *class compiler* into *class binary files* that the *MQ3T* run-times use to do the rule-based method dispatch. Additionally, the *class compiler* generates skeleton files (in *COBOL, PL/I,* or *C)* and make files. The programmer is entirely shielded from communications programming by the *MQ3T* run-times, save that he issues *MQ3T API* calls (typically *MQSEND/MQRPLY)* in order to send messages to other applications/objects and to reply to messages received. Consequently, the programmer does not explicitly fetch messages from queues – the run-time does this, activates the appropriate programme, and invokes the proper method according to a *rule* specified in the class file. An *MQ3T* programme is referred to as a *class,* of which an *instance* is created, when the programme is loaded into memory in order to start executing. There are three kinds of programmes: *Presentation Logic (PL), Business Logic (BL),* and *Data Logic (DL)* programmes. A web of programmes – referred to as a *job* – will be created, whenever a user starts a *PL* programme, the *job owner*. When the user terminates the *job owner,* all dependent programmes will also be terminated. Whereas *MQ3T* takes advantage of *MQSeries* as a messaging infrastructure for most programme-to-programme communication, *PL* programmes are somewhat special in that they only communicate with other *PL* programmes on the same workstation and do so without relying on *MQSeries* queues. Additionally, all messages to *PL* programmes will arrive in the *message procedure* of its *client window,* which implies that a *PL* programme may not have multiple methods. See [Wack98].

[2768] [SL98]. Cf. also [Hous98b] for some rules of thumb useful when choosing between asynchronous and synchronous communication.

[2769] Besides *RPC,* these include *DCE Threads Service, DCE Distributed Time Service, DCE Directory Service, DCE Distributed File System (DFS), DCE Diskless Support Service, DCE Security Service,* and the *Distributed Management Environment (DME)*.

[2770] Various estimations and forecasts of the size of the *MOM* market have been made. [Myer98] cites Steve Craggs of Candle Corp. as estimating that the core BQM market amounted to $160 million in sale in 1997 and forecasting that it would grow to $250 million in 1998. [Yeam98] refers to "various industry analysts" who estimate the combined market of *MOM* and message brokers at $300 million in 1997 and forecast that it will pass $700 million in 1999. Additionally, [Hard98] cites *IDC* as estimating the entire middleware market at $289 million in 1997, whereas [Hie99] cites the *Gartner Group* as expecting the market for message brokers to grow from $235 million in 1997 to $1.2 billion in 2001. In [Schu98], the *Gartner Group's DataQuest* division is cited as rating the "software license revenue in the core 1997 message-oriented middleware market, not including integration tools or broker-type extensions" at $128 million and "software license revenue for basic message-oriented integration middleware, not counting the basic messaging systems" at $225 million. In

- application integration – or *Enterprise Application Integration (EAI)* in the patois de jour – enabling the use of legacy software or bought-in software packages as *business function servers*[2771]
- electronic commerce and inter-corporate trade through *EDI* and other messaging technologies, possibly through third parties[2772]
- high-reliability mail
- legacy software access from the *Internet*[2773]

Although messaging and message queuing are venerable technologies that have been used in, for example, transaction processing systems since at least the 70s, commercial *MOM* software is a phenomenon of the 90s, and in terms of revenues *MOM* has only recently started to take off. Currently, the probably most widespread *MOM* product will be *IBM's MQSeries,* which was co-developed by *IBM's* Hursley Laboratories in England and *Systems Strategies, Inc. (SSI)* in the early 90s.[2774] *BEA* is another major supplier of middleware software providing an important *MOM* product, viz. *MessageQ* (previously *DECmessageQ),* which *BEA* acquired from *DEC* in February 1997 together with the *ObjectBroker ORB.* Most of the players on the *MOM* market are, however, small or very small companies, and many of these are specialised towards a certain market niche, such as health care or finance. *Netweave, Talarian, Level 8 Systems, Candle, TIBCO, Vitria, Active Software, PeerLogic, Verimation, HIE, MINT, Xing, Software Technologies Corporation (STC),* and *New Era of Networks (NEON)* are some of the more important of these. Incidentally, one of the earliest *MQM* products was *VCOM,* which was developed by *Volvo* during the late 80s and is now owned by *Verimation.*

1.2.28.2 Business Quality Messaging (BQM)

A catchword sometimes encountered in discussions of *MOM* is *BQM (Business Quality Messaging). BQM* designates a strain of highly reliable, transactional messaging and primarily targets mission-critical, possibly shrink-wrapped, distributed applications that communicate over corporate networks or across the *Internet.* For instance, *BQM* may be useful for e-commerce applications, systems where *EDI* is currently used, and many other transaction-oriented business systems. The term *Quality of Service (QoS)* is often used as a header for the features required by *BQM* systems, and in some products, it may be possible to choose between different levels of *QoS* when a message is dispatched. So, what are the benefits that *QoS* brings?

- *Guaranteed message delivery (GMD)* implies that every effort is made to have messages reliably delivered to the intended recipient, even though the recipient may be currently unavail-

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addition, the former category is forecasted to grow by nearly 50% during 1998-99 and by 40% during 2000, whereas the latter is expected to grow by 40% during 1998 and by 50-55% during 1999-2000.

2771 [Vitr98] cites *IDC* as characterising *application integration* as a "$40 billion problem" and *Forrester Research* as stating that "some companies" invest up to 40% of their *IT* budget on it, whereas [Call98a] states that "industry analysts" estimate that about $100 billion is spent on integration work world-wide and about 25-40% of "all IT budgets" is consumed by such work. [Yeam98] estimates the "investments in legacy environments" at $4 trillion. According to [Gill99], the *Gartner Group* estimates the *"EAI* market" at $6 billion by the year 2000, whereas the *Yankee Group* assesses the "application integration software market" at about $5 billion by the end of 2001 and the *Aberdeen Group* expects the size of the *EAI market* to grow to $1 billion-plus "within the next two years". See also [Lint00].

2772 [BQM98a] is a list of requirements for *Business Quality Messaging Service Providers (BSPs)* established by the *BQM Forum.*

2773 See [Korh97]. In contrast, *application brokers,* such as *Citrix WinFrame* or *SCO Tarantella,* make it possible to use an application that runs on a server through a web browser that runs on a client.

2774 See [Call98b-d] and [Hard98]. [Myer98] gives the number of customers as 5000 and the number of supported platforms as 35, whereas at http://www.ibm.software.com/ts/mqseries/family.html the number of customers is approximated to "more that 5,000" (sic!) and the number of platforms to "more than 35", while the estimated market share of the *MQSeries* is stated to be "more than 66%". At http://www.mesageq.com/communications_middleware/history.html, the sales for the *MQSeries* are reported as $15 million in 1995, $45 million in 1996, and around $100 million in 1997 – as a comparison, *CICS* sales are reported to amount to about $750 million/year. [Hard98] states that there are no less than 85 vendors "whose products add value to MQSeries". Currently, the *MQSeries* family consists of three products: *MQSeries,* which provides basic *MQM* functionality, *MQSeries Integrator,* which adds typical *message broker* functionality (based on a product from *NEON),* such as transformations, rules, routing, and the like, and *MQSeries Workflow,* which is the most full-featured of the three, also adding support for advanced flow control.

able.[2775] It should be possible for a sender to specify a message timeout and to ask for automatic notification upon message delivery or message timeout.[2776] The latter feature is sometimes referred to as *delivery assurance.*

- *Just-once* (or *exactly-once) delivery*[2777] ensures that a message is only delivered once.
- *Sequenced delivery* guarantees that messages are delivered in the order they were sent.

To support such *QoS* functionality, a *message queue server* may take advantage of message tracking, logging, journalising, acknowledgement schemes, timeouts, and a plethora of other well-known data communication techniques.

Furthermore, *BQM* software should support *transactional messaging* through *transactional queues* in order to be able both to provide *internal transactions* controlled by itself and to participate in *external transactions* controlled by an external *transaction co-ordinator.*[2778] The use of *MQM* implies a decoupling of the communicating parties in time that, unfortunately, clashes with the *ACID* requirements of distributed transactions, which more or less posit synchronous connections. A transaction either commits or aborts as an atomic unit – in the former case, all changes made during the transaction will be made persistent, whereas in the latter, they are all rolled back. During the transaction the resources affected – typically records in a database – will be locked. When *MQM* operations are part of a transaction, this may implicate that the transaction will have to remain pending for a considerable, possibly indefinite, amount of time, which is not generally considered acceptable behaviour for transactions and most probably will cause the transaction to time out. Consequently, it is customary for transaction-capable *MOM* software to include only the delivery of the message to a transactional queue into the transaction, whereas any subsequent actions performed by the receiver upon receipt of the message will be outside the scope of this transaction. Only when the transaction commits, the message will be actually delivered to the queue at the same time as all other resource changes such as database updates are made effective. In case the transaction aborts, the message will never be delivered to the queue. Hence, it will be impossible to wait inside a transaction for a reply message from the intended receiver of a message, as the request message will not be actually dispatched until the transaction has commited – any such attempt will cause a deadlock to occur.

The removal of a message from a transactional queue may indeed also be part of a transaction, but this transaction will be different from the one in which the message was dispatched. In this case, the message will not be considered delivered, until the transaction commits, and, if the transaction aborts, the message will be re-inserted into the queue. In a well-designed message-based system, both the send and receive operations will thus typically be made transactionally, although within different transactions. Additionally, it is common practice to have the receiver return a reply to the sender. This reply should then be posted within the very same transaction, in which the request is retrieved from the queue by the receiver, whereas the sender will have to retrieve the reply from the reply queue within a third transaction.

It may be thought that message queuing really disrupts the purpose of transactions – i.e. to guarantee data integrity. This is, however, only so, if both the sender and receiver of messages are directly involved in operations that need transactional protection, such as database updates, which by no means will necessarily be the case. For instance, the sender may enact an ordinary client in a three-tier client/server and thus delegate all

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2775 Nonetheless, some messages will never reach their destination. This will, for instance, be the case if the destination has been permanently removed from the network. Such undeliverable messages should be saved in a *dead letter queue.* [LD98] argues that for *in doubt* situations to be prudently handled *dead letter queues* must be monitored programmatically.

2776 Commonly, *Confirmation of Arrival (COA)* of a message into a queue and *Confirmation of Delivery (COD)* of a message to an application may be requested. Such *acknowledgements* (or *report messages)* will then be automatically sent to an *administration queue* (or *report queue)* by the queue manager. [BQM97] discerns three *message acknowledgement modes:* 'None' implies that no acknowledgements are sent, 'negative', that an *acknowledgement of failure* is sent when a message expires without having reached its destination, and 'positive' that an *acknowledgement of success* is sent when a message is successfully retrieved by an application and an *acknowledgement of failure* is sent when a message expires.

2777 [Dolg97] calls this feature *assured delivery,* whereas other authors use this term more or less synonymously with *guaranteed delivery.* At any rate, *just-once delivery* seems to be more expressive and to the point.

2778 See [Hous98b] for an elucidating disentanglement of the skein of possible combinations that present themselves when a choice is to be made between connection-oriented and connection-less communication, synchronous and asynchronous call styles, different transaction processing approaches, and different response horizons (immediate, eventual, and no response). Cf. also [Dick98] p. 248 et seqq.

database updates to the receiver, which in this case plays the rôle of the middle tier. Nevertheless, if both the message sender and receiver access databases transactionally, as will frequently happen in server-to-server messaging, transactional protection will be relaxed as compared to bona fide *distributed transaction processing.* Additionally, if in such a scenario the action triggered by the asynchronous message should fail, only under felicitous circumstances may *compensatory transactions* be used to restore data to a globally consistent state. Whereas the relaxation of the *ACID* properties of transactions may be acceptable for some kinds of data, it will certainly not be so for others. In case it is not, synchronous connections, which allow transaction context to propagate freely, should be opted for instead of asynchronous messaging. *RPC* or distributed object method invocations are examples thereof.

1.2.28.3 Message Switches, Workflow Systems, Interface Engines, and Message Brokers

In addition to all-purpose *MQM* software, there are a few categories of specialised messaging products.[2779] We will briefly describe four such categories of software: *Message switches, workflow* products, *interface engines,* and *message brokers.*

Message switches are intended for high-volume, high-speed, reliable, secure, and transactionally protected messaging and have their roots in the finance and insurance sectors. Typically, these systems were originally developed for (fault-tolerant) platforms such as *Tandem* or *Stratus,* although *UNIX* and *Windows NT* environments may now be supported as well.

Workflow systems typically have advanced support for conditional message routing and message transformations.[2780] A workflow system may either provide its own messaging engine or use a standalone *MQM* product as its infrastructure.

Interface engines originated in the early 90s within the health care sector as a means to help non-invasive integration between the heterogeneous applications being part of the often very thick alluvium of legacy software that over the years tends to deposit in a hospital and its departments. *Interface engines* typically support (low-volume) messaging and flexible message transformation/adaptation through wrapper technology.[2781] Originally, these products were mostly *UNIX*-based and strongly oriented towards health care applications. This orientation can still be perceived, e.g. in the widespread support for the *HL7* messaging format. Many *interface engines* have lately been generalised and refurbished into *message brokers,* which has caused the division line between these two categories to become increasingly fuzzy.

Currently, some of the most sophisticated *MQM* products are marketed as *message brokers (MBs).*[2782] Just like *interface engines,* which they are closely related to, *message brokers* differ from plain *MOM*/*MQM* products by being intended for non-invasive integration of heterogeneous applications. *Message brokers* are typically based on the *publish/subscribe* architecture and support a plethora of high-end messaging features, possibly including:

- *message queuing* over a plethora of transport protocols
- *message routing,* including support for more or less intelligent dynamic subject- and content-based routing as well as for the routing of multi-step, workflow-like processes in accordance with a set of *business rules*

[2779] See [Call98a]. At http://www.middleware.org/vendors/vendors.html, a listing of systems belonging to these and some other related categories is available.

[2780] See [OHE96a] p. 331 et seqq.

[2781] Strictly speaking, the *interface engine* is the layer of typically quite complex wrapper logic that maps – or "interfaces" – client requests to one or many accesses of one or many wrapped legacy applications and maps any returned data back to the format required by clients. From this basic sense of the word, *interface engine* has also come to signify products that make use of an *interface engine* internally.

[2782] See [Yeam98], [Call98a], and [SL98]. Most products advertised as *message brokers* come from comparatively small companies, such as *NEON (New Era of Networks), HIE, Active Software, MINT, PRL Scotland,* etc., although also *IBM* has recently entered this segment in co-operation with *NEON* (see [Call98b]). According to [Schu98], no company has more than 13% of this market and most companies had less than $10 million in license revenues in 1997. Cf. also [BRMS+96] p. 117.

- *message distribution,* including support for the *multicasting* and *broadcasting* of messages, possibly in parallel, and direct support for the *publish and subscribe* architecture (through a *hub and spoke* architecture)
- *self-describing messages,* which may be dynamically unpacked and interpreted
- large message sizes
- both *asynchronous* and request-reply *synchronous messaging* styles
- *message transformation* between message formats that differ with reference to syntax, semantics, order of elements, character sets, integer/floating point representations, etc.
- *message merging* and *splitting*
- a *message warehouse* for the storage of messages to be processed later
- a *message dictionary* (also known as an *interface repository)* holding meta-information about messages
- a *business rules engine* handling the message routing and message transformation rules, which preferably will be configurable through a *GUI*-based tool
- various *adapters* for wrapping or connecting to applications
- *security* and other *BQM* features, including support for transactional messaging, encryption of messages, message recovery, etc.
- *systems management, monitoring,* and suchlike *tools*

1.2.28.4 Industrial Consortia and Would-Be Messaging Standards

Currently, there are no real standards within the *MOM* area, although some incipient standardisation work has been brought about by a number of industrial consortia.[2783] For one thing, the *BQM (Business Quality Messaging) Forum,* founded in 1997 by *AT&T, Compaq, Intel, IBM, Microsoft,* and some other companies, is working on specifications, which may be regarded as possible embryos of such standards.[2784] A functional specification defines which functional requirements an *MQM* product must meet to qualify as *BQM compliant.*[2785] Another specification lists requirements for *Business Quality Messaging Service Providers (BSPs).*[2786]

Furthermore, in November 1998 the *Object Management Group* ratified a *CORBA Messaging* specification, although this specification does not concern itself with genuine *MOM*-style messaging, but rather with *RPC*-style *Asynchronous Method Invocations (AMIs).*[2787] Data may be returned from such an invocation either through a callback passed as an argument in the original call or through a *poller* object, which is returned from the call and may be queried for return data by the client at any time. There is also support for various *Quality of Service* functionality, such as message priorities and timeouts, and for *Time Independent Invocation (TII),* which is a *store-and-forward*-based mechanism that makes it possible to invoke currently inactive targets for later activation and to return data to inactive clients.

[2783] In the messaging area, there are also some noteworthy organisations, which are *not* working on *MOM* standards. The *Electronic Messaging Association (EMA)* is, for example, concerned with technologies and standards that promote the evolution of e-business and, in particular, *electronic messaging* understood in a very wide sense, which includes e-mail, fax, *EDI, LAN* messaging, wireless messaging, directory services and security issues, but its interest in *MOM* and *MQM* technology has hitherto been negligible. In contrast, the *Message Oriented Middleware Association (MOMA)* was an organisation entirely devoted to the promotion of *MOM,* but one that took no interest in standardisation efforts. In February 1999, *MOMA* changed its name to the *International Middleware Association (IMWA)* and at the same time expanded its charter "to include the full spectrum of technologies and solutions that enable Enterprise Application Integration (EAI)".

[2784] [BQM98b]

[2785] [BQM97]

[2786] [BQM98a]

[2787] [BEII+98]. Cf. also [Dolg99a].

Finally, the *Java Message Service (JMS),* which is part of *Java for the Enterprise,* provides a standard *Java* interface to *MOM* software, which may be expected to be supported by many *MOM* vendors.[2788] Various other *Java*-based interconnection mechanisms may occasionally provide an alternative to the use of *MQM* software, in particular the *InfoBus*[2789], which implements a publish/subscribe bus architecture, but also the *Linda*-like *Java Spaces*[2790] and *RPC*-style invocation using *RMI (Remote Method Invocation)*[2791] or a *Java ORB* supportive of the *CORBA Java* binding[2792].

1.2.28.5 MSMQ – A Messaging Infrastructure for Windows

The *Microsoft Message Queue Server (MSMQ),* which was released in December 1997, offers most of the bells and whistles that one would expect from a piece of full-blown *MQM/BQM* software. Currently, *MSMQ* comes in two variants, viz. a standard one shipped with *Windows NT Server 4.0, Standard Edition* and a somewhat more sophisticated version that ships with *Windows NT Server 4.0, Enterprise Edition.*[2793] Just like *MTS, MSMQ* redefined its market by coming free of charge and by virtue of its *COM* underpinnings and its accompanying easy-to-use administration tool, the *MSMQ Explorer.* And just like *MTS, MSMQ* targets the *Windows NT* platform only, making extensive use of system-specific features such as *Windows NT* multithreading, security, clustering, transaction handling, etc., and relies upon third-party products for interoperability with other systems and other messaging products.[2794]

From the point of vantage of *MSMQ,* a computer may play one of three rôles:

- A *dependent client* depends entirely on the *MSMQ server* as a *client proxy server* for message sending and reception as well as for all other queuing operations and, hence, will become dysfunctional when disconnected from the *server.*
- An *independent client* is itself capable of sending and retrieving messages and creating and removing (private) queues, even when disconnected from the *MSMQ server.*[2795]
- A *server,* which, besides, will run on the *Windows NT Server* operating system only, supports queue management through the *API* employed by *MSMQ Explorer,* performs message routing, and maintains the *MSMQ Information Service (MQIS),* a distributed database used to store configuration information about public queues, users, computers, networks, etc.

Messages as well as message queues have a large number of associated *properties.* Basic message properties include the *message body,* a unique *message id,* two kinds of time-outs[2796], and a *message label,* which is a kind of header intended for display in *MSMQ Explorer* and kindred tools. Another property may be used for specifying a response queue, where the receiver can post a reply to the original message. Each message has a *class* property, which indicates if the message is a regular message, an acknowledgement of some kind, or an error

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[2788] [HBS98]. See also [Habe99] and [Thom99], according to whom early implementations of *JMS* are available from *Estee Soft, Fiorano Software, Modulus Technologies,* and *Push Technologies.*

[2789] [Cola99]

[2790] [Sun99b].

[2791] [Sun97e]

[2792] See the section on *Interface Definition Language (IDL)* in [Sun98c].

[2793] The advanced version differs from the standard one by supporting cost-based routing, automatic re-routing upon network failures, more than 25 concurrent client connections, and the *MSMQ Connector,* which is used in bridges to other *MQM* products, e.g. in the *MSMQ-MQSeries Bridge* (previously known as the *FalconMQ Bridge)* licensed by *Microsoft* from *Level 8 Systems.* As an aside, the *MSMQ-MQSeries Bridge* also requires *Microsoft's SNA Server.*

[2794] There are *MSMQ* clients for *Windows95* and *Windows98* as well. In addition, *Level 8 Systems* offers a *FalconMQ Client,* which provides an *MSMQ* client for such platforms as *MVS, OS/2, OS/400, VMS,* and various *UNIX* flavours. Currently, *MSMQ* supports *TCP/IP* and *IPX* as transport protocols.

[2795] Since *independent clients* do not entertain their own replicas of the *MQIS* database, there are quite a few things they cannot do when operating in disconnected mode, such as locating queues or accessing queue and machine properties. See [Dick98] p. 37 et seq.

[2796] One time-out specifies the maximum time for a message before it must have reached its destination queue, the other the maximum time before it must have been delivered to the destination application. Both may be set to *INFINTE.*

report. It is also possible to assign to a message a priority that determines the placement of the message in the destination queue. Messages with the same priority are sorted according to a *FIFO* regime.

A particularly interesting message property determines whether *message delivery* should be *in-memory (express)* or *recoverable.* It should be noted that the delivery mode is specified on a per-message basis and is not a queue property. *In-memory messages* are not recoverable in case of system failure, but have very good performance characteristics.[2797] In contrast, *recoverable messages,* which are backed up to disk automatically, are resilient to system crashes, but considerably slower. Although the delivery of *recoverable messages* is guaranteed with reasonable reliability, there is no assurance that a message will not be delivered twice. At a substantial performance penalty, *recoverable messages* may be made *transactional* in order to guarantee such *just-once semantics.* For now, we will, however, postpone the discussion of *transactional messaging.*

There are also many other message properties pertaining to, for example, acknowledgement, authentication, encryption, tracing, journalising, and a number of other aspects of the messaging process. The interested reader will find information on these topics in *Microsoft's* documentation.[2798]

MSMQ supports both *public* and *private queues.* Whereas the former type of queue may be located from anywhere through the *MSMQ Information Service (MQIS),* with which all public queues must be registered, and is uniquely identifiable by a *GUID,* a queue of the latter category lacks a *GUID* and will only be accessible to clients which have been explicitly apprised about its whereabouts. In addition to a *GUID, MSMQ* queues may be identified by a (unique) network path name or be found through a search on the (non-unique) human-readable *label* property.

As for usage, there are two main classes of queues: *Application queues,* which are created by an application through an *API* call or by an administrator through the *MSMQ Explorer* and are used directly from applications, and *system queues,* which are created automatically by *MSMQ* and used by *MSMQ* for system housekeeping purposes. *MSMQ* may also create *internal queues* for store-and-forward routing of messages, although these queues will not be accessible to applications. There are four kinds of *application queues:*

- *message queues,* which are "ordinary" queues
- *response queues,* which are used to return reply messages from a message receiver to a message sender
- *administration queues,* to which acknowledgement messages are sent by *MSMQ*, in case the sender application so requests[2799]
- *report queues,* which are used to store the trace messages optionally generated when a message is propagated across network nodes on its way to a destination queue

Additionally, there are two kinds of *system queues:*

- *journal queues,* of which a new one is created, whenever a new *independent client* or *server* machine is added or an application queue is created, and in which journal messages are inserted, whenever a message is sent or received, provided this is requested by the setting of the relevant message and queue properties[2800]

[2797] As for performance optimisation in *MSMQ,* see [Micr98z].

[2798] See [Micr98w] and [Dick98] p. 316 et seqq.

[2799] A sender may request positive and negative acknowledgements either of the arrival of messages into the destination queue or of their retrieval from the destination queue. Alternatively, the sender may ask only for negative acknowledgement messages of either event. By default, no acknowledgement messages at all are issued. The choice between these five acknowledgement schemes is made on a per-message basis.

[2800] Such message journals are often referred to as *audit trails.*

- *dead-letter queues,* of which there is on every *independent client* or *server* machine one for transactional messages and another for non-transactional ones, both intended for the storage of undeliverable messages[2801]

In addition, there are various other queue properties. Every *MSMQ* queue must be specified to be either *transactional* or *non-transactional.* Queues, like messages, have *priority* values, and messages consigned for queues with a higher priority are forwarded before those headed for queues with a lower priority. It is also possible to limit the size of a queue through the *quota* property*,* to specify that only encrypted or only clear text messages, or both, may be passed to the queue, or to prescribe that only authenticated messages may be accepted.

Message posting in *MSMQ* is always non-blocking and asynchronous. Both synchronous reading and a number of asynchronous reading schemes are supported, of which the most frequently used will probably be *callback functions.*[2802] In addition, both destructive and non-destructive reading is supported.[2803] In contrast to, for example, *IBM's MQSeries, MSMQ* does not, however, support the automatic *triggering* of applications. Nor does *MSMQ* currently support the *publish and subscribe* architecture directly, although such support is expected to arrive in *COM+*.

1.2.28.6 MSMQ and BQM Functionality

MSMQ meets the basic *BQM* requirements about *guaranteed delivery, just-once delivery,* and *sequenced delivery* through its support for recoverable and transactional messages. It also supports various other *BQM* features, such as message timeouts, a variety of acknowledgement schemes, message and queue priorities, dead letter queues, audit trails (through *journal queues),* message tracking (through *report queues),* end-to-end message authentication, message encryption (through the *MS Crypto API)*, and digitally signed messages. Incidentally, the tight integration between *MSMQ* and *Windows NT* is also drawn on for *BQM* purposes. For instance, the *Windows NT* event log is used for error logging[2804] and *Windows NT ACL (Access Control List)* security is taken advantage of for fine-grained control of which users or groups of users are allowed to make read, write, and administrative operations on a certain queue.

In *MSMQ, transactional messaging* is provided through *transactional queues.*[2805] An *MSMQ* queue is either *transactional* or *non-transactional,* as specified by an immutable property at queue creation time. Messages may only be sent to a transactional queue within a transaction, although there is no such obligation when a message is retrieved from a transaction queue. Indeed, if a transactional queue is remote, the retrieval must not be transactional – transactional retrieval is only possible with local transactional queues. For non-transactional queues, sending and receiving must always happen outside a transaction.

Two categories of transactions, *internal* and *external,* exist in *MSMQ: Internal transactions* are entirely controlled by *MSMQ* and, consequently, may not span *resource managers* other than *MSMQ* itself. An *MSMQ internal transaction* is demarcated by explicit *BeginTransaction* and *Commit/Abort* calls and, hence, is said to be *explicitly called.*[2806] There is also a special *single-message transaction,* which is *implicitly called* and is useful for sending

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2801 *Transactional messages* that cannot be delivered are always saved to the *transactional dead-letter queue* of the sender machine, whereas an undeliverable *non-transactional message* may or may not, depending on a message property, be saved to a *non-transactional dead-letter queue* on the machine where the failure happened, which may be the sender, the destination, or any intermediary machine.

2802 Alternatively, *MSMQ* may signal a particular thread within a process that a message has arrived through the *Windows NT* event mechanism. *MSMQ* may also use a *Windows NT* completion port to inform a process of message arrival. See [Dick98] p. 162 et seq. Cf. also [Rich97] p. 745 et seqq.

2803 [Dolg98e] mentions that the *Falcon* pre-release version of *MSMQ* supported message retrieval based on user defined fields, but that this feature was removed in the sharp release. Possibly, this feature will be reintroduced.

2804 An administrator may configure which error types are to be logged in this way.

2805 See [Dick98] p. 257 et seqq.

2806 As *MSMQ* supports both a higher-level *COM*-based interface and a lower-level *C API,* transaction demarcation may be done in two – actually quite different – ways. When using the *COM* model, the programmer creates a *transaction dispenser* object and calls its *BeginTransaction* method to start the transaction. This method returns an *MSMQ* transaction object, which is passed as a parameter in the *Send* and *Receive* calls and whose *Commit* and *Abort* methods demarcate the end of the transaction. This scheme is also used for *external DTC transactions,* although a *coordinated transaction dispenser* is then used in stead of the regular one. For a discussion of the *API* transaction calls, see [Dick98] p. 276 et seq.

a single message with exactly-once semantics to a transactional queue without having to bother with explicit *BeginTransaction* or *Commit* and *Abort* commands. *Single-message transactions* cannot be used for retrieval. *Internal transactions* are significantly more efficient than *external* ones, as they can be specially optimised for *MSMQ*.[2807]

External transactions, on the other hand, take advantage of *Microsoft's DTC*[2808] as a *transaction manager* and are not limited to the use of *MSMQ* as the one and only resource manager, but may span e.g. database management systems and other resource managers. There are three kinds of *external transactions:*

- *DTC transactions,* which are *explicitly called* transactions managed by *DTC*
- *MTS transactions,* which are *implicitly called MTS automatic transactions,* also managed by *DTC* under the covers[2809]
- *XA transactions,* which are *implicitly called*[2810] *XA* transactions managed by an *XA* transaction manager through the *XA mapper* and *DTC*

When a message is sent or retrieved, its transaction type is specified through a transactional parameter. If an *explicitly called transaction,* i.e. an *internal transaction* or a *DTC external transaction* is used, the transaction object used in such explicit transactions should be assigned to the transactional parameter. Otherwise, one of four constants, each corresponding to a particular style of transaction handling, may be specified.[2811]

When a message is sent transactionally, it will not be appended to the transactional queue until the transaction commits. In case the transaction aborts, the message will never be dispatched. When a message is transactionally retrieved from a local transactional queue, the message will be re-inserted into the queue, if the transaction aborts. It is possible to send and retrieve multiple messages within one transaction, although any attempt to send off a request and then wait for the reply in the same transaction will cause a dead-lock, as the request message will not be actually released to the queue until the transaction commits.

1.2.28.7 MSMQ – Architecture and Administration

An important feature of *MSMQ* is its naming and directory service, the *MSMQ Information Service (MQIS)*, in which information about users, machines, queues, routing, network configuration, etc. are stored. However, *MQIS* does not lodge the messages proper, but these are stored in memory-mapped files. Currently, *MQIS* requires *SQL Server* as its storage infrastructure, although in the future the *Active Directory* will be used instead. *MQIS* makes it possible to search for and locate queues at run-time, and, hence, messages may be sent from any machine to any other without setting up "channels", as is necessary in some other *MQM* products, including *IBM's MQSeries*. The data held by *MQIS* is distributed and replicated between *MSMQ* servers in accordance with the sophisticated hierarchical architecture that will be outlined below.

Earlier, the three rôles a machine may play, *dependent client, independent client,* and *server,* were mentioned. Actually, there are a number of different *servers*. Firstly, each enterprise must have a single *primary enterprise controller (PEC),* which is an *MSMQ* server that in its *MQIS* database will hold various pieces of information of enterprise-wide relevance, such as the enterprise and *PEC* names, the topology of the *MSMQ* servers and networks, various digital certificates used for authentication, etc. In many cases, an enterprise will consist of multiple *sites,* each of which will have one *primary site controller (PSC)* and any number of *backup site controllers (BSCs),* which are used not only to back up data stored at the *PSC,* thereby enhancing the resilience to system faults considerably, but also for balancing the load. The *PSC* and the *BSCs* primarily hold information perti-

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[2807] [Dick98] p. 346.

[2808] See p. 581 above.

[2809] It should be noted that because of the *MTS* thread pooling mechanism, *MTS components* cannot use asynchronous message retrieval directly. Instead, a client programme should register the callback and call the component when a message has arrived. See [Dick98] p. 271 et seq.

[2810] Explicit *XA* transaction demarcation calls will be made in the application that initiates an *XA* transaction.

[2811] MQ_NO_TRANSACTION, MQ_SINGLE_MESSAGE, MQ_MTS_TRANSACTION, MQ_XA_TRANSACTION. The default is MQ_MTS_TRANSACTION.

nent to the current *site,* e.g. about its users, computers, and queues. Data are replicated from the *PEC* to the *PSCs* and from the *PSCs* to the *BSCs* at regular intervals. By default, intersite replication is made every 10 seconds and intrasite replication every 2 seconds, although some critical data are replicated immediately upon modification. Additionally, *routing servers,* which are used exclusively for routing, network protocol bridging, and store-and-forward queuing and, as a consequence, do not maintain any *MQIS* replica, and *connector servers*[2812]*,* which are taken advantage of in order to connect to other *MQM* software than *MSMQ,* may be set up. It should be noted that in some cases one server might take on more than one of the above rôles; for instance, a *PEC* may also be a *PSC.*

If possible, *MSMQ* will deliver messages directly to their destination queues. If the machine where the destination queue is located is not on the same *connected network (CN)*[2813] as the sending machine, it will be necessary to *route* the message over intermediary nodes through a *store-and-forward* mechanism. *Routing* may be either *intra-site* or *inter-site. The* links between the *sites* have configurable *costs* associated with them, which are used to determine the cheapest inter-site routes for each message.[2814] Upon network failure, *MSMQ* will automatically change the routes so as to circumvent the failing link. Furthermore, *routing servers* may be used as intra-site and inter-site *session concentrators,* thereby reducing the number of costly sessions attached to a server at the expense of an extra network hop.

Just as *MTS, MSMQ* comes with a *GUI* administration tool, the *MSMQ Explorer,* although, in contrast to *MTS Explorer,* it is not currently capable of acting as a snap-in for the *Microsoft Management Console. MSMQ Explorer* makes it easy to add and delete queues on a machine, adjust queue priorities and other queue properties, send test messages to queues, and ping remote machines. It is also possible to configure most other aspects of an *MSMQ* installation through the *MSMQ Explorer,* including the network set-up, routing, security, message tracking, etc. Many administrative operations and tasks may also be made programmatically through the *MSMQ API,* although this will seldom be preferable.

1.2.28.8 The Programming Model of MSMQ

MSMQ provides two different programming models: A low-level *C API,* and a high-level *COM* model, consisting of a small number of *COM* objects exposing *dual interfaces.* The *COM* objects are easily used from *COM*-capable languages, such as *Visual Basic, Visual J++,* or *Visual C++,* and here we will look into the *COM* model only, although it should be recognised that to manipulate some of the more arcane aspects of *MSMQ* it may occasionally be necessary to take advantage of the *C API* as well. The *COM* objects implemented by *MSMQ* will now be briefly surveyed. Many technical details will be left out.[2815]

MSMQMessage represents an *MSMQ* message and holds all message properties, of which the more important ones were briefly discussed above.[2816] The message object has a single method, *Send,* which is used to dispatch the message into a queue.[2817]

MSMQQueue contains only a few properties, of which the most significant will be the *QueueInfo* property. It holds an *MSMQQueueInfo* object that in turn holds most of the queue properties treated of above. In addition, *MSMQQueue* exposes a number of important operations:

[2812] *Connector servers* are only available in the *Enterprise Edition* of *Windows NT.* Available *connectors* include the *MSMQ-MQSeries Bridge* and a connector for *Microsoft Exchange.*

[2813] Machines on a *connected network* communicate over the same network protocol (TCP/IP or IPX).

[2814] Costs may take on values between 0 and 999,999. Cost-based routing is only available in the *Enterprise Edition* of *Windows NT.*

[2815] More details are found in [Dick98] p. 281 and the *MSMQ* documentation [Micr98w].

[2816] See [Dick98] p. 316 et seqq. for a list of these.

[2817] [Sess98a] points out that there is a strange asymmetry in having the *Send* operation in *MSMQMessage* and the different message retrieval operations in *MSMQQueue* and argues that *Send* should have been located in *MSMQQueue* instead.

- *Receive* retrieves the first message in the queue. For all read operations, it is possible to specify a timeout (in milliseconds). The default is INFINITE.
- *ReceiveCurrent* retrieves the message at the current *cursor* position.
- *Peek* reads the first message in the queue without dequeuing it.
- *PeekCurrent* reads the message at the current cursor position without dequeuing it.
- *PeekNext* non-destructively reads the message at the position next to the current cursor position and updates the cursor.
- *Reset* sets the cursor position to the start of the queue.
- *EnableNotification* is called by a client to register an *MSMQEvent* object, through which it will be notified when a message arrives in the queue or, alternatively, when a message arrives at the current cursor position of the queue. It is possible to specify a timeout and, in case no message has arrived when the timeout expires, the *ArrivedError* method of *MSMQEvent* will be called in stead of the *Arrived* method. When a message has arrived, *EnableNotification* must be called again, in case the client wants to be notified also about the next message arrival.
- *Close* closes the queue.

MSMQEvent includes two user-defined operations, *Arrived* and *ArrivedError,* which are invoked upon message arrival and message read errors, respectively, in case an application has registered an *MSMQEvent* object with a queue (through the *MSMQQueue::EnableNotification* method) in order to be able to read messages in the queue asynchronously.

MSMQQueueInfo is used for queue management and contains a number of important queuing operations:

- *Create* is used for the creation of queues.
- *Delete* deletes a queue.
- *Open* opens a queue for reading and returns an *MSMQQueue* object.
- *Refresh* reads the queue properties from *MQIS* afresh.
- *Update* stores the modified queue properties in *MQIS*.

MSMQQueueInfos is a collection of *MSMQQueueInfo* objects, which is returned from *LookupQueue,* the single operation of the *MSMQQuery* object. This object is used to search for a particular queue. In such a search, a number of different search criteria, possibly combined by Boolean operators, may be employed.

MSMQTransactionDispenser and *MSMQCoordinatedTransactionDispenser* are used for *explicitly called* transactions and both have a single *BeginTransaction* method, which returns an *MSMQTransaction* object. *MSMQTransactionDispenser* is used for internal *MSMQ* transactions, whereas *MSMQCoordinatedTransactionDispenser* is used for transactions co-ordinated by *DTC*. The *MSMQTransaction* object exposes the methods *Commit* and *Abort*.

Finally, *MSMQApplication* contains the single operation *MachineIdOfMachineName,* which is used to retrieve a special machine identifier for a computer.

The above *COM* objects will be quite simple to use, and most of the time the programmer will only need to use a few operations for opening and closing queues, sending and receiving messages, and, perhaps, locating a particular queue. In a typical scenario, the queue is first located, then opened, messages sent and/or received, and, upon completion of the task to be performed, the queue will finally be closed again.

It is of note that anything may be sent in the body of a message as long as the 4 MB limit on message size is not transgressed.[2818] A common choice will be to use a customised fixed-length structure as the message body, which, however, couples sender and receiver tightly together. A more flexible approach, mitigating the adverse effects of coupling considerably, is to use a self-describing message syntax, such as that of *HTML, XML* or *Newi's* semantic messages.[2819] It is also quite possible to send, for example, a *Word* document, *ADO Recordsets, COM* objects supporting *IPersistStream,* or even *DLLs* or executable binary files in a message, although this may give raise to severe security issues.[2820]

1.2.28.9 Integration of MSMQ with Microsoft's Enterprise Infrastructure and Other Software

MSMQ is tightly integrated with the other elements of *Microsoft's* enterprise architecture, and this integration will be further deepened when *COM+* is released. For instance, the automatic transactions of *MTS* may encompass *MSMQ* send and receive operations, and it is possible to send and receive messages from *Active Server Pages* in *IIS*. Furthermore, *MSCS* may be used to enhance the availability of an *MSMQ*-based architecture through automatic fail-over.

It is also possible to use *MSMQ* as a transport for e-mail and forms messaging through the *MSMQ Mail Services,* which consists of the *MSMQ Exchange Connector* and the *MSMQ MAPI Transport Provider.* These facilities also make it possible to send and receive e-mail messages and forms in an *MSMQ* application. There is a special *Message Queuing Services Mail SDK,* comprising both an *API* and a set of *COM* objects, which may be used for developing e-mail capable messaging applications.

It is also possible to use *MSMQ* as a transport protocol for *RPC;* this variety of *RPC* is sometimes referred to as *RPC-MQ.*[2821] *RPC-MQ* invocations may be made either in *synchronous* or *asynchronous mode.* Only the *synchronous mode* permits the returning of data through *out* parameters or as function return values, but also implies that a time-dependence is created between client and server, since both must be up and running simultaneously for the data exchange to be feasible. Return data will in this case be handled transparently by the *RPC* subsystem through a reply queue. The *asynchronous mode* only supports *in* parameters, but allows invocations of applications that are not currently available.[2822] Applications communicating in this loosely coupled way are occasionally said to be *time-independent.*[2823]

1.2.29 INTERNET INFORMATION SERVER (IIS)

The kingpin of *Microsoft's* server-side web technologies is its web server, the *Internet Information Server (IIS),* the current version of which is 4.0.[2824] *IIS* is tightly integrated with the *Windows NT Server* operating system as well as with *MTS* and *MSMQ,* and just like *MTS* and *MSMQ* as well as some other closely related products, such as the *Certificate Server* meant for management (issuance, revocation, and renewal) of digital certificates and the *Index Server* used to support text searches on a web site, it is part of the *Windows NT Option Pack,* which is available to all comers free of charge. It supports run-of-the-mill *HTML/HTTP* web page publishing with some added bells and whistles, but for more advanced features, such as support for e-commerce functionality, it will have to be supplemented with other software – for which *Microsoft* does charge.

[2818] Of course, larger amounts of data may be split into multiple messages. It would have been nice if the *MSMQ* infrastructure had done the message splitting and message pasting transparently.

[2819] Cf. [Dick98] p. 142 et seqq.

[2820] Id. op. p. 172 et seqq.

[2821] [Micr98j]

[2822] Additionally, *Windows NT 5.0* will provide support for *asynchronous RPC,* including support for *asynchronous DCOM* invocations. *Asynchronous RPC* may be used over any wire protocol that is available for *RPC.* There will be support for a variety of mechanisms to notify a caller of the completion of a call, including events, callbacks, polling, window messages, and *Windows NT I/O completion ports.* See [Micr98j] for more details on *asynchronous RPC* and [Micr98f] for information on asynchronous *DCOM.*

[2823] [Kirt99] p. 391

[2824] [Micr98τ] is the documentation of *Microsoft Internet Information Services SDK.* [DB98a] gives a bird's-eye view of *Microsoft's* web server technologies. See also [EE98b] p. 329 et seqq. and [Whil98].

Currently, there are three packages, which include *IIS* as a component, but augment it with additional functionality. These packages, which are marketed under the *BackOffice* label, are the *Site Server,* which is intended to support the sharing of information over a corporate intranet, the *Site Server, Commerce Edition,* which enhances *IIS* with support for transactional on-line commerce, advertisements, personalisation, membership management, and site analysis, and *Microsoft Commercial Internet System (MCIS),* which adds mail, news, chat, connection services, etc. to the *Site Server, Commerce Edition* and is geared towards *Commercial Service Providers (CSPs).*

In addition to these packages, there are various free-standing *BackOffice* products, which may be used together with *IIS,* such as:

- the *Proxy Server,* which supports firewall security, content caching, and the like
- the *SNA Server,* which provides connectivity with *IBM* legacy systems
- *SQL Server,* which is *Microsoft's* relational database management system
- the *Exchange Server,* which provides support for a wide range of messaging and collaborative technologies, including mail, news, chat, workflow, connectivity with *Lotus Notes, X.400,* etc.[2825]

To complete the picture, *Windows NT Server NetShow Services* add server-side support for the use of streaming media, such as audio and video, over the *Internet.*

1.2.29.1 Active Server Pages

A prominent feature of *IIS* is its support for *Active Server Pages.*[2826] An *Active Server Page (ASP)* is a server-side *DHTML* web page augmented with embedded scripting code. When an *Active Server Page* (i.e. a page with the .ASP extension) is accessed from a client-side web browser, its embedded scripts will be executed on the server, possibly modifying the contents of the page dynamically, before the page is delivered to the client. *ASP* server-side scripts may make use of ***automation objects,*** also known as *ActiveX objects* or *Active Server Components (ASCs),* including *ActiveX Data Objects (ADOs)* for database access. Thus, *ASPs* provide a versatile alternative to the complex and awkward system interfacing achieved through *CGI (Common Gateway Interface)* programmes – typically written in languages such as *C* or *Perl* – or through *ISAPI (Internet Server Application Programming Interface) extensions* and ***filters*** written in *C/C++.*[2827] By reusing various existing *Active Server Components,* a web page designer working with the *ASP* technology may easily tailor the web page to the end user and to the capabilities of the user's browser, access a database or the file system, handle state data on a per-session or per-application basis, link suites of web pages together, add rotating advertisements to a page, etc.

Essentially, an *Active Server Page* is a perfectly ordinary *DHTML* web page, where server-side ***scripts*** and ***output expressions*** may be added within special delimiters. The scripts are executed and the output expressions evaluated and written to the page on the web server, before the page is delivered to the client. Scripts are delimited by <% and %> and output expressions by <%= and %>. Such scripts and output expression are intended solely for use on the server and are removed from the page when it is sent to the client. Hence, *Active Server Pages* are browser-neutral, or rather as browser-neutral as the contents of the generated web page. A simple example illustrates how scripts and output expressions may be used:

[2825] The *Exchange Server* exposes its services through the *Collaboration Data Objects (CDO,* previously known as *OLE Messaging* or *Active Messaging),* a set of *Automation* objects, which provide a high-level interface to *Microsoft's* messaging infrastructure *MAPI (Messaging Application Programming Interface).*

[2826] See [Micr96f], [Winn97c], [Woda98], and [Winn98c]. The *Active Server Pages* technology was code-named *Denali* before its release to the public. *Sun* is currently working on a *Java* pendant, brazenly named *Java Sever Pages (JSP).*

[2827] For maximum performance and low-level control, it may still be a good idea to use *ISAPI.* In order to access a database, the *IIS* programmer may also use the *Internet Database Connector (IDC),* an *ISAPI DLL* that uses *ODBC* for data access. A third alternative is to use the *RDS ActiveX* control at the client side in order to achieve three-tiered database access, thereby removing the need to reload the entire web page at each data access. See below p. 614. *ISAPI* was originally devised by *Process Software* and is used in some non-*Microsoft* web servers as well.

```
<HTML>
<HEAD>
<TITLE>A puzzling page of mystery</TITLE>
</HEAD>
<BODY>
<%  If Time < #12:00:00 AM# And Time >= #12:00:00 PM# Then
       greeting = "Good morning"
    Else
       greeting = "Good evening"
    End If
%>
<P>
<%= greeting %> <%= Request.ServerVariables("REMOTE_USER") %>,
browsing with <%= Request.ServerVariables("http_user_agent") %>!
The time here in Lund is <%= now %>
</P>
</BODY>
</HTML>
```

As the script is executed and the four output expressions are evaluated and written to the page, a perfectly ordinary *HTML* page is generated, possibly looking like this:

```
<HTML>
<HEAD>
<TITLE>A puzzling page of mystery</TITLE>
</HEAD>
<BODY>
<P>
Good morning Sherlock Holmes,
browsing with Internet Explorer 5.0!
The time here in Lund is 12/9/98 10:00:00 AM
</P>
</BODY>
</HTML>
```

Scripts may be written in any language implemented by an *ActiveX Scripting* engine, although the *Microsoft*-supplied *VBScript* and *JScript* engines will certainly be the ones most frequently used. The dialects supported by the server versions of these two engines are slightly different from the client variants; for instance, commands that interact with the user through dialogue and message boxes are not supported. It is possible to mix different scripting languages in one *ASP*.

1.2.29.2 Components in Internet Information Server

As exemplified by the *Request* object referenced in the example, *IIS* supports the use of server-side *ActiveX objects,* also known as *Automation* objects or *Active Server Components (ASCs).*[2828] *IIS* features a number of such objects as *built-in* or *intrinsic objects:*

- *Request* contains information about the *HTTP* request passed from the client, including the *HTTP* query string and its variables, any form or user certificate data or cookies included in the request as well as a few environment variables.
- *Response* is used to send information back to the client, including the *HTML* web page text, cookies, *URL* redirections, etc.
- *Server* supports the creation of *ActiveX objects* as well as various server utility functions, including file and database access, the checking of browser capabilities, etc.

[2828] See [Winn97d] and [Brew97] p. 279 et seqq. The term *Active Server Component (ASC),* which was used mainly in descriptions of the *Active Platform,* seems to have fallen into disuse together with the most of the *Active Platform* terminology, although the special requirements of *IIS* on components would indeed motivate a special term for *IIS* components. Here we will not shun the designation *Active Server Component* for an *Automation* object that is used in *IIS*.

- *Session* is used to store state data about the current user session.
- *Application* is used to store state data shared across user sessions and includes *Lock* and *Unlock* methods to prevent corruption through simultaneous user access.
- *ObjectContext* is used during transaction management.

Additionally, various *installable components* (also known as *base objects)* are included with *IIS* and may be installed as needed. Some of the more important of these are:

- The *database access component* supports script access to any *ODBC* or *OLE DB* compliant data source through *ActiveX Data Objects (ADOs).*
- The *content linking component* may be used to create sequential links between web pages and tables of contents for suites of pages thus linked.
- The *file access component* provides for file access on the server.
- The *browser capabilities component* may be used to analyse the capabilities of a browser in order to tailor the *HTML* code to the functionality implemented by the browser.
- The *permission checker component* uses password checks to protect files.
- The *page counter component* supports the popular page counter.
- The *ad rotator component* facilitates the scheduled rotation of different advertisements.

Furthermore, the *Collaboration Data Objects (CDO,* formerly *Active Messaging* or *OLE Messaging)* may be taken advantage of for sending messages (e.g. e-mail) from the server. It is also possible to use third-party[2829] or custom *ActiveX objects* – including *XML scriptlets* – in *IIS* scripts.[2830] If an *Active Server Component* makes use of the *intrinsic* or *base* objects of *IIS,* it cannot generally be reused in other *ActiveX* containers, although it may be designed so as to support execution both inside and outside an *Active Server Page.* Additionally, *Java servlets* may be used on an *Active Server Page* through the *JRun* utility from *Live Software.*[2831]

An instance of an *Active Server Component* may be created either through an <OBJECT> tag on an *Active Server Page* or through a call to *Server.CreateObject.* Every instance of a component in *IIS* has a specific *scope,* which may be *page* (default), *session,* or *application scope.* The *scope* can be specified in the <OBJECT> tag, whereas an object created with *Server.CreateObject* has *page scope,* until it gets *session* or *application scope* by being assigned to a variable in the *Session* or *Application* object. An object with *page scope* will only be available inside a certain page, whereas an object with *session scope* may be shared between many pages belonging to the same user session. For instance, it may be useful to give *session scope* to a data component that retrieves a record set that will be displayed across several pages. *Application scope* implies that the component instance is shared between all users of an application and should only be used in special cases, the stock example of which will be a page counter component.

[2829] [Fenb98] catalogues a plethora of such components.

[2830] [Whil98] discerns four kinds of such components:

- *line of business components* encapsulates essential business rules and functions for a certain category of web applications such as e-commerce, order processing, or insurance systems
- *utility components* are used to access system functionality, such as event logging, e-mail, file access, etc.
- *data components* are used for data access
- *presentation components* interact with the user through the *Request/Response* objects and output data in a format that can be displayed by a web browser (typically *HTML)*

[2831] See http://www.livesoftware.com/products/jrun. Besides, through its *Chili!ASP* software *Chili!Soft* offers *ASP* support for other popular web servers than *IIS,* including *Apache, Netscape Enterprise* and *FastTrack,* and *Lotus Domino,* in configurations for both *Windows NT* and some *UNIX* variants. For more details, see http://www.chilisoft.com.

Just like *MTS, IIS* maintains a pool of *STA* threads, in which the *Active Server Components* execute.[2832] Components with *page session scope* should support either the *apartment model* or the *"both" model* (i.e. both the *apartment* and the *free-threaded model),* whereas for objects with *session scope* the *"both" model* will be preferable. Components with *application scope* should support the *"both" model* and additionally aggregate a free-threaded marshaller. Other combinations may or may not be legal, but will have various undesirable implications such as bad performance.

1.2.29.3 Web Applications and Integration with MTS and MSMQ

IIS supports the notion of a *web application,* which is a collection of *Active Server Pages* and *Active Server Components* that reside in (or below) the *application root,* i.e. the starting-point directory of the application, assigned to it in the *IIS MMC* snap-in tool. A *web application* is started by the first user that pays a visit to one of its pages. It maintains its own *Application* object as well as one *Session* object per user. Additionally, *web applications* provide support for process isolation and receive start and end events, for which handler scripts may be written.[2833] Each *application* has its own *Web Application Manager (WAM),* a *COM* component that loads the *ASP* run-time and other *DLLs* and handles *HTTP* requests for the application.

The web application concept rests on the tight integration of *IIS* with *MTS* and *MSMQ.*[2834] *MTS* will handle transaction co-ordination (commit, abort, rollback) for all scripts and objects on a page declared as transactional[2835], and these scripts and objects will share a common transaction context represented by the built-in object *ObjectContext.*[2836] Only transactional resources supported by *MTS,* such as *Microsoft SQL Server* and databases supporting the *XA* protocol, can be rolled back automatically, whereas, for example, changes to the file system or *ASP session* and *application* objects cannot. Since the *transactional events OnTransactionCommit* and *OnTransactionAbort* are fired when a transaction commits or aborts, the programmer may amend this by doing the rollback of non-transactional resources explicitly. Transactions may also span multiple *ASP* pages[2837], and it is possible to explicitly abort or commit a transaction from a script through the *ObjectContext* object; otherwise, a transaction ends when the script execution completes or the transaction is aborted. In addition, *MSMQ* may be taken advantage of in order to send updates asynchronously to remote servers, which may not be currently available. These updates are guaranteed to be delivered, as soon as the target becomes available.

The integration with *MTS* also facilitates *process isolation,* which is a way to bring about *fault isolation* and better support for component evolution.[2838] By default *IIS, ASPs,* and *ASCs* run in the same process. Since no inter-process marshalling will be needed in this case, this configuration provides the best performance characteristics. A *web application* – or rather its *ASPs* and components – may run in a separate *MTS*-managed surrogate process (i.e. as an *MTS server package),* and it is also possible to separate its *ASPs* and components into different *MTS* processes. Finally, *ASPs* may run in the *IIS* system process, while components are factored out to a separate process. *Web applications* that run in the *IIS* process will be handled through an *MTS library package.* At the expense of some performance, multi-process configurations will make the web server more reliable, since a crash will not affect the entire server, but will be limited in its effects to a particular *MTS* process, which, additionally, will be automatically restarted by *MTS*.

[2832] The *IIS* thread-pooling model implies that different invocations of an *IIS* component instance may not execute in the same thread, which is to say that *thread affinity* is not maintained. Consequently, thread-local storage must not be used by *IIS* components, nor must such components create other components in the standard *COM* way, which may imply the creation of a proxy in thread-local storage. Instead, *ASCs* should always use *Server.CreateObject* for object creation, although this will undermine their usefulness outside *IIS*. Cf. [Box98d].

[2833] This is done in the *global.asa* file located in the application root directory. Additionally, it is possible to declare objects with *session* or *application scope* in *global.asa.*

[2834] See [Utzs98], [Patt98a], and [Micr98ϕ].

[2835] This is done at the first line of the page through the @*TRANSACTION* directive.

[2836] Transactional *ActiveX components* must be registered and configured as requiring a transaction (or a new transaction) in *MTS Explorer*.

[2837] This can be done by using the *Server.Transfer* or *Server.Execute* methods.

[2838] The support for component evolution is enhanced, since in-process components cannot be reloaded unless the server process they run in is restarted. To have to restart *IIS* each time a component is updated may be highly undesirable.

IIS also supports a wealth of other functionality that one expects to find in a web server, including various features pertaining to security, authentication, certificates, encryption, logging, performance monitoring and tuning, internationalisation, etc. However, we will not enquire into these topics here.

1.2.30 COM+

The first time the plans for *COM+,* the next generation of *COM,* were made public was at the *Microsoft Professional Developers Conference (PDC)* in September 1997. In the original press release announcing *COM+,* only two, although admittedly important, concepts of *COM+* were mentioned:[2839]

- *interceptors* facilitating the engraftment of snippets of extrinsic code on *COM* objects
- *data binding* between *COM* object fields and database fields

Various other pieces of information soon seeped out, emanating both from the *PDC* presentations and from various other sources.[2840] It appeared that *COM+* would integrate *COM, DCOM,* and *MTS,* sport a fairly extensive range of component services (transactions, data binding, persistence, in-memory database, load balancing, security, events, etc.), and implement the novel concept of *attribute-based programming* (also referred to as *declarative programming* or *Automatic Everything).*

Attribute-based programming will allow the *COM+* programmer to concentrate on the business logic proper, whereas circumstantial issues such as object location, object state management, transaction handling, security, etc. will be handled by making annotations declaratively – i.e. setting *attributes* – either directly in the source code or through *MTS Explorer*-like administrative tools.[2841] The technical facilitator of *attribute-based programming* will be the new extension mechanism *interceptors.* At run-time, service-related behaviour, which mirrors the attribute settings available in an *MTS*-style *object context* associated with each *COM+* object, will automatically be added through such interceptors, which may intercept method invocation and method return, instance creation and deletion, assignment of an instance to a reference, error returns, and, possibly, some other actions as well.[2842] For example, code for security checking, pre- and post-condition verification, synchronisation, data binding, transaction handling, logging, or performance monitoring may be easily added to an object through interceptors.

However, the most distinctive feature of *COM+* was reported to be a run-time library that would simplify *COM* programming – and in particular *C++ COM* programming – through an in-process binary object model largely inspired by the object model of the *Java* language and, in particular, by the way *COM* had been integrated with the *Java* object model in *Microsoft's Java* implementation.[2843] Some of the highlights of this object model will be:

[2839] [Micr97a]. Cf. also [Micr97b].

[2840] See, for example, [Malo97], [Sess97b], [Kirt97a-b], [Chap97d], [Chap98b], [ER98], [Long98], [Pfis97b], and [Szyp98a] p. 217.

[2841] It will also be possible to set some attributes programmatically at run-time.

[2842] Interestingly, *OMG* soon followed suit by adding support for *interceptors* to the *CORBA 2.2* specification [OMG98b] (p. 18-1 et seqq.). For a range of years, a related mechanism, *composition filters,* has been thoroughly researched by a group at the *University of Twente.* See e.g. [AT98] and [AB92a].

[2843] Other sources of inspiration will include *Visual Basic* and the *C++*-based *Active Template Library (ATL).* [Gard99], [FGB99], and [Fole99] recount some rather nebulous rumours that *Microsoft,* or a faction within *Microsoft,* is considering an entirely new language called *COOL (C++ Object-Oriented Language)* as a possible alternative both to *Java* and to an enhanced *COM+*-based future version of *Visual C++*. Confusingly, *COOL* is also reported to be used as a code-name for a number of *COM+*-based extensions to *Visual C++*. Possibly, *COOL* the new language is but a canard, whereas *COOL* the *C++* extension refers to the addenda to the *C++* language necessitated by the *COM+* run-time.

- default implementation of a large number of frequently used *COM* interfaces as well as various other pieces of functionality[2844]
- better support for dynamic memory management through automatic reference counting, garbage collection, and integration with programme language memory allocation constructs, such as the *new* operator of *C++*
- *COM* object *constructors,* to which a list of arguments may be passed in order to facilitate instance initialisation, and *destructors* useful for clean-up tasks when an object is about to be deallocated
- safe references combined with opaque object layout impervious to direct pointer access
- support for field access in *COM* objects
- support for multiple interface inheritance between *COM+* interfaces as well as for virtual methods and single implementation inheritance between *COM+* classes (possibly written in different programming languages)
- replacement of explicit *IDL*-based interface definitions by implicit definitions expressed in native programming language constructs (e.g. *Java interfaces)*
- support for *interface-based, method-based,* and *persistent events,* of which *interface-based events* largely correspond to today's *connection points* and *method-based events* are like *interface-based events,* except that the event handler methods do not need to be part of an interface, whereas *persistent events* are loosely coupled publish-subscribe events that do not even posit that publishers and subscribers are running simultaneously
- a unified set of types available to all *COM* clients[2845]
- mandatory, pervasive, and considerably enhanced use of meta-data (as compared to today's *COM* type libraries), rendering components entirely self-describing, thereby making it possible to expunge once and for all the artificial dichotomy between *vtable* interfaces and *dispinterfaces* by obviating the need for *dispinterfaces* altogether – and in the end presumably also for the *proxies* and *stubs* of *vtable* interfaces – through the reliance on dynamic introspection-based marshalling

In short, *COM+* will offer the *C++* programmer much of the same versatility as *Visual Basic* and *Java* programmers already enjoy long since. To take advantage of these salubrious features, the *C++* programmer will, however, have to avail himself of tools and compilers that support the *COM+* library as well as various *Microsoft*-specific extensions to the *C++* language, such as the new *coclass* and *cointerface* keywords intended for the definition of *COM* classes and interfaces.

During 1998, the above picture has gradually been revised, and a first version of *COM+* has been announced, providing a unified *Component Services Architecture*[2846] or *activation and interception architecture*[2847] through the amalgamation of *COM, MTS,* and to some extent also *MSMQ,* into a single piece of universal middleware, whereas the *COM+* run-time and many of the features mentioned above have been postponed to later *COM+* versions.[2848] The first version of *COM+* will be part of *Windows 2000* and is expected to comprise four services, viz. the *Dynamic Load Balancing Capability,* the *Queued Components Service,* the *Publish and Subscribe Events*

[2844] [Malo97] enumerates the *COM* interfaces and other features that would be implemented by the run-time on the programmer's account: *IUnknown, IDispatch, IConnectionPoint, IConnectionPointContainer, IProvideClassInfo, IPersist*,* class factories, *DllRegisterServer, DllUnregisterServer, DllUnlockServer, IDL,* and type information.

[2845] [Kirt97b] lists these types as *Boolean, BSTR, Byte, Char, ClassRef, COM interface pointer, Const, Currency, Date, Double, Float, HRESULT, Int, Long, Pointer, Reference counted object reference, Safearray, Short, Sized array, Unsigned char, Unsigned int, Unsigned long, Unsigned short, UUID, Variant,* and *Void.* It should be noted that all data types currently supported by *Automation* are provided.

[2846] [Schw98]

[2847] [Kirt99] p. 384

[2848] See e.g. [Micr98v], [Moel98], [McKa98b], [Schw98], [Chap98c], and [Kirt99] p. 383 et seqq.

Services, and the *In-Memory Database (IMDB),* which all were included in a first *COM+* beta released in August 1998.[2849]

The major attraction of *COM+* will probably be its tight integration with *MTS,* which will cease to exist as an individual product. This integration will show up in many ways. Firstly, all *COM+* objects will have an *MTS*-style *object context,* in which will be stored the configuration *attributes* related to various *COM+* services. As a side-effect, the need for a special *IObjectContext::CreateInstance* method, as in today's *MTS,* will evanesce. Furthermore, the *MTS Explorer* and the *DCOMCNFG* tool for the configuration of *DCOM* will be unified into the new *COM Explorer* tool, which also may be controlled through scripting by means of a number of administrative *COM+* objects. Since the general philosophy of *COM+* is to bolster the declarative approach dubbed *attribute-based programming*, where "point-and-click" administrative actions, smart use of the *interception* mechanism, and infrastructure implementation will replace routine programming tasks as far as possible, the rôle *COM Explorer* will play will be a pivotal one.

Configuration data and meta-data not included in the type library of the component will be held in a new *component library* (a *.clb* file), which will obviate the need for storing registration data in the *Windows registry* and writing component registration code. Consequently, *COM+* components will be totally self-describing by themselves.[2850] In addition, *COM Explorer* will be able to export *server, library,* and *client applications,* of which the former two categories correspond to *MTS server* and *library packages,* respectively, whereas the latter one refers to automatically generated *Microsoft Installer (MSI)* applications that may be used together with the upcoming *Zero Administration for Windows* technology in order to facilitate the dissemination of applications from a central *Windows 2000 Class Store* to multiple client machines.

Interceptors as described above will be taken advantage of in the *COM+* re-implementation of *MTS,* which also will support *object pooling* and *object recycling.* Pooled objects must not be dependent on *thread affinity*[2851]*,* but should comply with either the *free-threaded model* or a new threading model called the *thread-neutral apartment model,* in which an object is always running in the caller's thread, be it an *STA* or an *MTA thread.*[2852] *COM+* will also add support for *Compensating Resource Managers (CRMs),* which will allow non-transactional resources to take part in *DTC*-managed transactions and undo actions through *compensating actions* facilitated by means of a logging mechanism. In addition, various security enhancements, including support for a *Kerberos*-based authentication mechanism, will be included in *COM+.*[2853]

The *dynamic load balancing service* will allow the instances of a *COM+* class, which has been so configured, to be evenly distributed between a number of servers that participate in an *application cluster.* This is done by intercepting each instance creation request in order to route it to the currently least loaded server.[2854] Subsequent method calls will be forwarded to the proper instance transparently from the vantage point of the client.

The *queued component service* will provide support for one-way asynchronous communication with *MSMQ* as a transport provider.[2855] On the client-side, a *Recorder* component will record ordinary *COM* invocations of a server object, until a *commit* command is issued, upon which these calls will be marshalled into a single *MSMQ*

[2849] See [Trot98b]. [Swen98b-c] gives some tidings about a *COM+*-capable *Visual C++ Technology Preview* released by *Microsoft* somewhat later.

[2850] The new registration service of *COM+* will continue to support registration in the *Windows system registry* for backward compatibility reasons. This registration service is expected to be used by tools such as *COM Explorer,* the *Windows 2000 Class Store,* and the *Internet Component Download* services (see above p. 547).

[2851] If an object requires *thread affinity,* it must execute in one and the same thread for its entire lifetime. This will, for instance, be necessary if the object uses thread-local storage.

[2852] In *COM+,* the *thread-neutral apartment model* will be the default threading model. There will also be support for various synchronisation schemes. For a *COM* object to be poolable it must support aggregation, implement *IObjectControl,* return *TRUE* from *IObjectControl::CanBePooled,* and have a number of pooling-related attributes properly set.

[2853] See [Kirt99] p. 390 et seq.

[2854] Load will be measured in terms of response time. However, the algorithm used for selecting the least loaded server will be pluggable and, hence, the default algorithm may be replaced with a custom one.

[2855] Cf. p. 604 above, where, in addition to *MQ-RPC,* the upcoming support for *asynchronous RPC* and *asynchronous DCOM* is briefly discussed.

message and dispatched to an *MSMQ* queue. If this operation fails, the transaction will be aborted. At the server-side, a *Listener* component will dequeue the messages from the *MSMQ* queue and forward them to a *Player* component, which does the unmarshalling and invokes the *COM+* server object. If a message cannot be retrieved from the queue, the transaction will be aborted and the message re-inserted into the queue.[2856] No return data are allowed in calls of queued components, and, hence, only *in* parameters may be used in *queueable interfaces*. An interface is declared *queueable* in *COM Explorer,* and any *COM class* that contains a *queueable interface* will be a *queueable class* and any *COM component* that contains a *queueable class* will be a *queueable component*. The methods of a *queueable interface* may be called both indirectly through a queue and directly through an ordinary *COM* method call. The access style to be used is selected when the *COM* object is created.

The *COM+ event service* will support loosely coupled component interconnections through the publisher-subscriber pattern.[2857] *Publishers* declare any *COM event class* they support in an *EventClass* object, which they register with the *EventSystem* object of the event service. Subscribers implement the interfaces of the event classes, in which they take an interest. Subscription requests may be made administratively or programmatically through an *EventSubscription* object that is registered with the aforementioned *EventSystem* object. The event service will automatically provide an implementation of each registered event class, which the publisher will call when it wants to fire an event. These calls will then be forwarded to the subscribers by the subscription service. There are also mechanisms for the filtering of events, intended to be used both by publishers and subscribers.

Finally, the *In-Memory Database (IMDB)* may be used for storing or caching database tables in memory.[2858] It may operate both as an *OLE DB* provider, thereby being accessible through the *ADO* interfaces*,* and as a resource manager in transactional scenarios. Additionally, *IMDB* will be used to provide an alternative *COM+* implementation of the *Shared Property Manager* of *MTS*.

[2856] If the message retrieval fails repeatedly, the message will finally be sent to a dead-letter queue. The client should monitor this queue in order to be able to spawn *compensating transactions*.

[2857] [BRMS+96] p. 339 et seqq.

[2858] [Kirt99] p. 397 points out various restrictions on data to be handled by *IMDB*.

1.4. DATA ACCESS SERVICES – COMPONENTS FOR *UNIVERSAL DATA ACCESS*

UDA (Universal Data Access) is *Microsoft's* designation for its overriding database and information access strategy, which is also a key component of the entire *DNA* compages.[2859] The name *Universal Data Access* sets *UDA* apart from the strategy – advocated by some database vendors – of gathering all kinds of data in a single *universal database* or *universal storage,* which is an approach spurned by *Microsoft* for several reasons. For one thing, it will be difficult to support widely different types of data efficiently in a single *DBMS.* In addition, it will be exceedingly laborious and expensive to convert existing data to the single format required by a universal database. In contrast, *UDA* supports connectivity to multiple different types of *data sources* through a set of common abstraction interfaces. These *data sources* may hold structured as well as unstructured data and will span the whole gamut of data formats, from ordinary tabular relational data to *ISAM* files, text files, word processing documents, bitmaps, spreadsheets, directory data, e-mail messages, *HTML* pages, etc.

Microsoft Data Access Components (MDAC) is *Microsoft's* implementation of the *UDA* architecture, comprising *ODBC (Open Database Connectivity), OLE DB,* and *ADO (ActiveX Data Objects).*[2860] *ODBC* is the basic abstraction *API* – and a well-established *de facto* standard – for access to databases and other kinds of data stores, whereas *OLE DB* and *ADO* provide higher-level *COM*-based data interfaces, which may be – and very often are – built on top of *ODBC.* Simply put, *OLE DB* provides a set of comparatively low-level ("system-level") *COM vtable* interfaces, whereas *ADO* provides a set of high-level ("application-level") *dual COM* interfaces, implemented by *automation objects,* which, in turn, make use of *OLE DB* internally.[2861]

It should be noted that although *Microsoft's* relational database management system *SQL Server* and its future name/directory service *Active Directory* are both part of *DNA,* they are not included in the *Data Access Services* of *DNA,* which are wholly independent of the storage infrastructure. We will not discuss *SQL Server* or the *Active Directory* technology here, although we will adjoin some rumblings about *Storage+, Microsoft's* would-be future unified storage model.

1.2.31 *ODBC* AND *OLE DB*

ODBC is a *C API* based on the *Call-Level Interface (CLI)* specification of *X/Open* and *ISO/IEC.*[2862] At run-time, the *ODBC API* is exposed by *Microsoft's ODBC driver manager,* which, in turn, makes use of various *ODBC drivers* for the interaction with the data sources. An *ODBC driver* often derives its lineage from the company that developed the *data source* it interfaces, although *Microsoft* and some other firms provide third-party drivers for popular *DBMS* and other products, such as *Oracle's RDBMS.*

In order to retrieve or update data, the programmer passes an *SQL* query – couched in standard *SQL* rather than in the native dialect of the data source – as a string argument to an *ODBC API* function. This access style suits relational databases well, but may be awkward when one is working with non-relational data sources, and many data sources will only be able to support a subset of the full *ODBC API* and *SQL* data access language. For example, read-only data sources will not be able to support any update *SQL* syntax. Therefore, a number of distinct *interface* and *SQL conformance levels* have established, with which *ODBC* drivers will have to comply. It is possible to programmatically query a driver about which *conformance levels* it supports.

In contrast to *ODBC, OLE DB* is not geared primarily towards relational *SQL* databases, but supports non-tabular data more naturally, although all data will be exposed to clients as *rowsets,* i.e. collections of rows of data.[2863] *OLE DB* may take advantage of *ODBC* to access tabular data, although it may also access such and other kinds of data natively. As the *OLE DB API* makes use of *COM* interfaces, a programmer may use the

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[2859] [Kirt99] p. 53 et seqq., [Rauc97], [Laza98], [Skon98], and [EE98b] p. 263 et seqq. all provide bird's-eye views of *UDA.*

[2860] These technologies are subsumed under the *Microsoft Data Access SDK (DASDK).* [Micr98g-j] is the technical documentation hereof, whereas [SH98] primarily treats of *ADO 2.0.*

[2861] [Micr98k] gives a succinct overview of the objects available in *ADO 1.5,* and [Micr97g] explains the relationship between *OLE DB* and *ADO.*

[2862] [Micr97r] contains the documentation of *ODBC 3.0.* As of this writing, the most current version of *ODBC* is 3.51. Although *ODBC* primarily is a *Windows* technology, it has also been ported to *Apple's Macintosh* and various *UNIX* platforms.

[2863] [Micr97s] documents *OLE DB 1.1,* [Micr98n] *OLE DB 2.0.*

QueryInterface mechanism to find out which capabilities (i.e. *COM* interfaces) *OLE DB* provides for a particular data source. *OLE DB* provides a *COM*-based object model encompassing objects such as *Data Source, Rowset, Command,* and *Session*, which we, however, will not dwell upon here, since the more approachable *ADO* object model is strongly favoured and commended by *Microsoft* currently and to a large extent has superseded the *OLE DB* one in the field. Moreover, the *ADO* object model largely parallels that of *OLE DB,* although the particulars, including the names of the objects and methods, differ.

In *OLE DB* and *UDA,* three kinds of components are discerned: *Data providers,* which expose data stored in *data sources* such as relational databases, *data consumers,* which use such data, and *service components,* which process data in various ways. *ADO* is a *data consumer,* since it consumes data provided by a variety of *OLE DB data providers.*[2864] *Service components* are used to add functionality that typically is applicable only to certain kinds of data sources, such as query, cursor, and transaction management. One particularly important *service component* provided in the *MDAC* implementation of *ADO* is the *Remote Data Service (RDS).*[2865]

1.2.32 ACTIVEX DATA OBJECTS (ADO)

ADO (ActiveX Data Objects) is to be understood as *Microsoft's* state-of-the-art data access technology, being in its 2.0 incarnation as of this writing. Currently, *ADO* is strongly promoted by *Microsoft*[2866], and it is supposed to replace a number of older *Microsoft* technologies such as *DAO (Data Access Objects)* and *RDO (Remote Data Objects).*[2867] Since *ADO*, in contrast to *OLE DB,* supports *dual COM interfaces* and, thus, its objects are *automation objects,* they may be effortlessly used from a wide range of languages and applications that are capable of acting as *automation controllers,* including *Microsoft's Visual Basic, Visual J++, Visual C++, Microsoft's* scripting languages, and many other pieces of *Windows* software.

The *ADO* object model comprises eight objects: *Connection, Command, Parameter, Recordset, Field, Error, Property,* and *Collection.* A typical *ADO* scenario will include the creation of a *Connection* to a data source, the construction and issuance of a *Command* – optionally modified by a *Collection* of *Parameter* objects –, and, in case the command was a query, the receipt of a *Recordset* consisting of rows of *Field* objects, which are stored in a local cache for easy retrieval and update.[2868] *Connection, Command, Recordset,* and *Field* all contain a *Collection* of *Property* objects, whereas *Connection* features a *Collection* of *Error* information objects and *Recordset* a *Collection* of *Field* objects, which define its column layout (name and data type) and hold the actual data values. Although there is no separate row object, it is possible to traverse, add, delete, and change the rows in a *Recordset.* Through *cursors,* of which there is an assortment of different types*, ADO* supports the notion of a *current row* in every *Recordset.*

Additionally, *event* handlers provide support for asynchronous operations. It is possible to asynchronously connect to a data source, asynchronously execute a command, and asynchronously retrieve a (large) result set. When an asynchronous operation has been initiated, notifications will be issued by the *Connection* and *Recordset* objects as a transaction or data retrieval operation progresses.

[2864] In *DASDK* are included *OLE DB data providers* supporting *SQL Server, Oracle, Microsoft Access* (i.e. the *Jet* database motor), *ODBC,* the *Active Directory,* and the *Microsoft Index Server.* [SH98] p. 231 et seqq. presents a performance comparison between the native and the *ODBC*-based *OLE DB providers,* substantiating the natural supposition that the former category has the whip-hand as far as performance is concerned. In addition to ordinary *tabular data providers (TDPs), OLE DB for OLAP (Online Analytical Processing)* specifies *multidimensional data providers (MDP),* which expose data as multidimensional views instead of as ordinary two-dimensional ones.

[2865] Other service components are the *Cursor Service,* the *Synchronization Service,* and the *Shape Service.* See [Micr97g] for an explanation of the rôles of these.

[2866] For example, *ADO* and *Microsoft's Java* framework *WFC (Windows Foundation Classes)* are compared with *Sun's Java*-based database interface *JDBC* in [Micr98m].

[2867] [Micr97f] gives some guidelines for choosing among the different data access interfaces (including *DAO* and *RDO)* available in *Visual Basic.* Although compatible with any *ODBC* data source*, DAO* was primarily tuned for *Microsoft Access* and its *Jet* database engine and was notorious for bad performance when used with other data sources. In contrast, *RDO,* which was built on top of *ODBC,* was much more efficient for *ODBC* data sources, such as *SQL Server* and other relational databases. The object models of *DAO* and *RDO* have influenced that of *ADO* considerably. [SH98] p. 234 et seq. provides evidence that *DAO* is still much faster than *ADO* for *Jet* database access.

[2868] As a side-point, version 2.1 of *ADO* will support saving the data held in a *Recordset* to an *XML*-tagged file as well as resuscitating a *Recordset* from such a file. *ADO 2.1* is supposed to be delivered as part of *Internet Explorer 5.0.*

1.2.32.1 The Remote Data Service (RDS)

Whereas *ADO* by itself only provides for direct connections to data, i.e. two-tiered architectures, the *Remote Data Service (RDS)* adds support for data access through an intermediary, which may be the middle tier of a three-tiered client/server application or, in case a web application is built, *Microsoft's Internet Information Server (IIS).*[2869] *RDS* provides mechanisms for caching data in *ADO disconnected Recordsets*[2870] and for easy binding of remote data to client-side controls. The *RDS* middle-tier consists of *automation objects,* which in this context are referred to as *business objects.*[2871] These *business objects* may execute inside *Microsoft Transaction Server* in order to reap the benefits of automatic transaction management, connection pooling, thread pooling, and suchlike. It is of particular note that the lifetime of *RDS business objects* does not extend beyond a single method call, which makes them particularly well suited for execution inside *MTS*.

A client may connect to the business objects through generic proxies obtained by calling the *CreateObject* method of the *RDS* object *RDS.DataSpace.*[2872] Alternatively, it may choose to work with ordinary *ADO Recordset* objects[2873] or with the *RDS ActiveX* data control *RDS.DataControl.*[2874] Both *Recordsets* and *RDS.DataControl* are capable of managing the *RDS.DataSpace* and the proxies transparently. Each proxy wraps a *disconnected Recordset* cache, and updates may easily be submitted from the *Recordset* to the data source, using an optimistic locking scheme. Since no locks can be held by a disconnected *Recordset,* there is always a risk when submitting updates that someone else has already altered the data to be updated, in which case an error will be reported and the client will have to take proper action. *RDS.DataControl* may be associated with a *data-aware ActiveX* control in order to *bind* the control directly to a *Recordset.*[2875] For example, such an *ActiveX* control may be a combo box, a tabular widget, or a text box, which automatically displays the contents of the *Recordset* on a web page or a *Visual Basic* form.

The proxies handle the marshalling and unmarshalling of data and the communication with the business objects through *HTTP, HTTPS, DCOM,* or, in case the business objects reside on the client machine, through in-process calls.[2876] As a rule, *HTTP* and *HTTPS* will be used across the *Internet,* whereas *DCOM* will be preferred in an intranet or over a *LAN*. To make *RDS* operative, an *ISAPI (Internet Server API)* extension, the *ADISAPI (Advanced Data ISAPI),* must be installed on the server. This piece of software essentially acts as a

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[2869] [Bath98] and [SH98] p. 163 et seqq. describe *RDS* as implemented in version 2.0 of *MDAC*. *RDS* was originally known as *ADC (Advanced Data Connector).*

[2870] A *disconnected Recordset* has no associated *Connection* object and, hence, cannot maintain locks in the database.

[2871] [Geor95a], which predates *RDS/ADO,* suggests that *OLE Automation* objects may be used to implement *business objects*.

[2872] A *Visual Basic* code snippet will illustrate a simple query:

```
    Dim dataSpace        as New RDS.DataSpace
    Dim dataFactoryProxy as Object
    Dim recordSet        as ADODB.Recordset

    Set dataFactoryProxy =
dataSpace.CreateObject("RDSServer.DataFactory","http://dna.lth.se")
    Set recordSet = dataFactoryProxy.Query("DSN=dsn", "SELECT * FROM test")
```

[2873] The *Visual Basic* code would look like this:

```
    Dim rs as New ADODB.Recordset
    rs.Open "SELECT * FROM test","Provider=MS Remote;Data Source=dsn;Remote Server=http://dna.lth.se"
```

[2874] In this case, the programmer sets a number of properties on the control (typically the connect string, a server identifier, and a *SQL* string) and calls *Refresh:*

```
    Dim dataControl as New RDS.DataControl
    dataControl.Connect = "DSN=dsn"
    dataControl.Server = "http://dna.lth.se"
    dataControl.SQL = "SELECT * FROM test"
    dataControl.Refresh
```

[2875] The *RDS data control* is one of the *data source objects (DSOs)* shipped together with *Internet Explorer*. Cf. supra p. 556.

[2876] [Micr97g] and [Bath98] foreshadow *OLE DB/ADO/RDS* support for *XML* as a marshalling and persistence format, and according to [Micr98σ] such support is present in the *RDS* of *ADO 2.0* through the *SOAP* protocol (see above p. 567). *XML* tags may embellish data with semantic meta-information in a way not dissimilar to the semantic tags of *News's* semantic data streams.

stub that receives the *RDS* client requests, creates business objects accordingly, and returns the resulting *Recordsets* to the client proxies in an appropriately marshalled format. *RDS* provides a default server-side business object, *RDSServer.DataFactory,* which internally employs *ADO* for data access. The use of the default business object is referred to as ***implicit remoting***. Alternatively, one may choose to do ***explicit remoting*** by writing one's own business objects in an *Automation* capable language, if, for one reason or other, one would like to add business logic at the server-side.

1.2.33 STORAGE+

Currently, only very sparse information has trickled out about *Microsoft's Storage+,* which reportedly is planned to unify the storage models of the *Windows* and *Windows NT* file systems, the *SQL Server RDBMS,* and *Microsoft Exchange* into one layered file system.[2877] The *Windows NT* file system will provide the base layer, upon which will be laid out a service layer featuring logging, transactioning, caching, and replication mechanisms. The third layer will encompass a record store and a transactional file system, both accessible through an indexing service. At the top of *Storage+*, there will be both an ordinary operating system model and a societal model, which will organise information around social concepts such as people, places, times, etc. – seemingly somewhat in the same vein as *Taligent's* user interface *People, Places, and Things*. Just as is the case for *Forms+,* the time frame for *Storage+* is well beyond the arrival of *Windows 2000,* which presently is believed to occur either late in 1999 or during the year 2000.

[2877] [Fole98a-b]. Whether this file system will be equivalent to the "object-oriented" file system of *Cairo* foreshadowed by *Microsoft* long since is moot. The *Cairo* file system was supposed to be based on the *structured storage* technology of *OLE,* which imparts on files an internal navigable tree-shaped storage structure reminiscent of a miniature file system. Cf. [Broc95] p. 1150 et seq. and [OHE96a] p. 457.

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